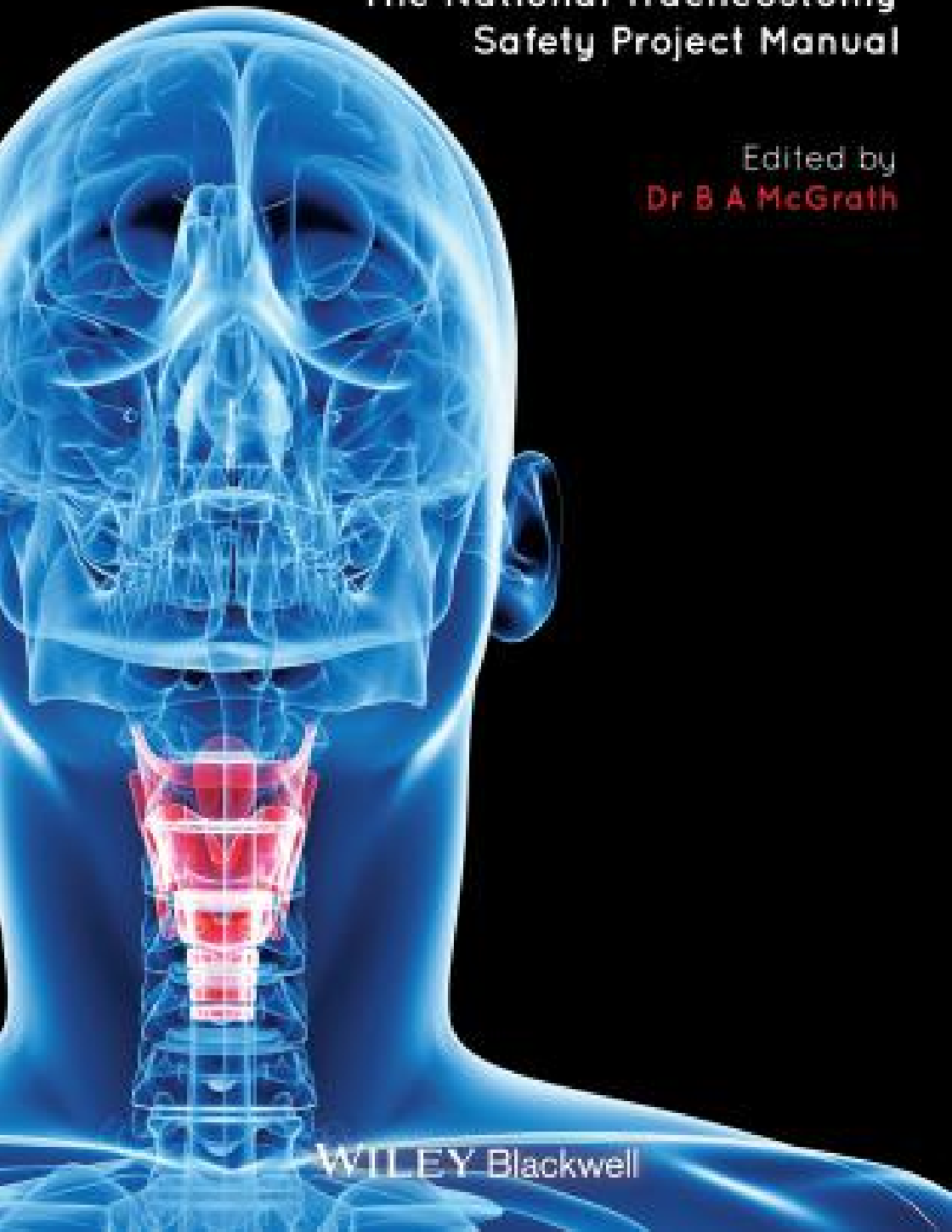
Comprehensive Tracheostomy Care

The National Tracheostomy Safety Project Manual

Edited by
Dr B A McGrath



WILEY Blackwell

Table of Contents

Personal Acknowledgements

Title Page

Copyright

NTSP Editorial board

Preface

Acknowledgements

Competing interests

Disclaimer

Contact details and further information

Updates

Executive summary key recommendations

Key issue

Action

Chapter 1: How the NTSP resources were developed

Chapter 2: What is a tracheostomy? What is a laryngectomy?

What is a tracheostomy?

What is a laryngectomy?

Chapter 3: Why and how a tracheostomy is performed

Indications for a tracheostomy

Anatomy relevant to tracheostomy

Types of tracheostomy

Techniques for inserting a tracheostomy

Performing a tracheostomy

Chapter 4: Different types of tracheostomy tubes

Cuffed tubes

Uncuffed tubes

Fenestrated tubes

Single-cannula tubes

Double-cannula tubes

Tubes with sub-glottic suction

Adjustable flange tracheostomy tubes

Choice of tracheostomy tube

Factors influencing temporary tracheostomy tube choice

Tubes from different manufacturers

Chapter 5: Management of the day-to-day needs of the patient with a tracheostomy and laryngectomy

Daily checks

Humidification

Suctioning

Stoma care and securing the tube

Management of the inner cannulae

Oral care and swallowing

Cuff management

Changing tracheostomy tubes

Equipment required for a tracheostomy tube change

Weaning, downsizing and planning for decannulation

Decannulation

Bedside equipment

Humidification and speech after laryngectomy

Patient information sheets examples

Chapter 6: Complications

Complications associated with a tracheostomy

Chapter 7: Red flags

What should you do if you detect a red flag?

Chapter 8: Emergency management of the patient with a tracheostomy or laryngectomy

Guideline development

Patent upper airway: the ‘Green algorithm’

Laryngectomy: the ‘Red algorithm’

Comparison with previously published guidelines

Chapter 9: Paediatric tracheostomy care (with Great Ormond Street Hospital, London)

Background

Indications for tracheostomy in a child

Differences between adult and paediatric airways

Nursing and general care of the paediatric tracheostomy patient

Staff and carer competency guides

Emergency management of the child with a tracheostomy

Discharge from hospital with a paediatric tracheostomy

Chapter 10: Infrastructure considerations

Introduction

Hospital inpatient management

Draft tracheostomy policy outline

Chapter 11: Competencies for staff caring for patients with tracheostomies or laryngectomies

Tracheostomy care: competency assessment criteria

Chapter 12: Courses

Chapter 13: Human factors

Introduction

Human error

Error chains

Communication

Situation awareness

Fatigue

Decision making

Leadership: people, behaviours

Summary

Acknowledgement

Bibliography

Index

Personal Acknowledgements

A great many people have put a lot of hard work into the production of this book and the accompanying courses and resources.The authors would like to thank all the contributors for their efforts. NTSP are now working in partnership with the Advanced Life Support Group, ALSG. Our thanks go to JaneMooney,Medical Editor at ALSG, and the staff atWiley for their support and assistance in the production of this text.

For Emma, Cerys and Bethan-thanks for the love, support and patience.

Comprehensive Tracheostomy Care

The National Tracheostomy Safety Project Manual

Edited by

Dr Brendan McGrath

MB ChB MRCP FRCA DICM EDIC AHEA FFICM
Consultant in Anaesthesia & Intensive Care Medicine
University Hospital of South Manchester
Manchester, UK

Honorary Senior Lecturer
University of Manchester
University of Salford

On behalf of the Working Party of the National Tracheostomy Safety Project

WILEY Blackwell

NTSP
www.tracheostomy.org.uk

This edition first published 2014 © 2014 by John Wiley & Sons, Ltd.

Registered office: John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial offices: 9600 Garsington Road, Oxford, OX4 2DQ, UK

The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

111 River Street, Hoboken, NJ 07030-5774, USA

Permission granted to reproduce for personal and educational use only. Commercial copying, hiring, lending or sale is prohibited.

The NTSP is acknowledged as the author of this manual.

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell

The right of the author to be identified as the author of this work has been asserted in accordance with the UK Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

The contents of this work are intended to further general scientific research, understanding, and discussion only and are not intended and should not be relied upon as recommending or promoting a specific

method, diagnosis, or treatment by health science practitioners for any particular patient. The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of fitness for a particular purpose. In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of medicines, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each medicine, equipment, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. Readers should consult with a specialist where appropriate. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read. No warranty may be created or extended by any promotional statements for this work. Neither the publisher nor the author shall be liable for any damages arising herefrom.

Library of Congress Cataloging-in-Publication Data

Comprehensive tracheostomy care : the National Tracheostomy Safety Project manual / edited by Dr. B.A. McGrath.

p. ; cm.

Includes bibliographical references and index.

ISBN 978-1-118-79277-3 (cloth)

I. McGrath, B. A. (Brendan Anthony), 1974- editor of compilation. II. National Tracheostomy Safety Project (Great Britain)

[DNLM: 1. National Tracheostomy Safety Project (Great Britain) 2. Tracheostomy--Practice Guideline. 3. Laryngectomy--Practice Guideline. 4. Patient Safety--Practice Guideline. WF 490]

RF517

617.5′33– dc23

2013041262

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Cover image: Reproduced with permission from Shutterstock, Inc.

Cover design by www.hisandhersdesign.co.uk

NTSP Editorial board

Dr Brendan McGrath

Consultant in Anaesthesia & Intensive Care Medicine, University Hospital of South Manchester;

Honorary Senior Lecturer, University of Manchester and University of Salford

Dr Dougal Atkinson

Consultant in Anaesthesia & Intensive Care Medicine, Central Manchester Foundation Trust

Dr John Moore

Consultant in Anaesthesia & Intensive Care Medicine, Central Manchester Foundation Trust

Dr Lucy Bates

Consultant in Anaesthesia & Intensive Care Medicine, Royal Bolton Hospital

Dr Carl Gwinnutt

Resus Council (UK)

Sr Sam Westwell

Critical Care Nurse Consultant, Salford Royal Hospital

Dr Anna Perks

Consultant Anaesthetist, Salford Royal Hospital

Mr Nick Calder

Consultant ENT surgeon, NHS Lanarkshire

CN Tim Baker

ICU Nurse Practitioner, University Hospital of South Manchester

Mr Alan Jervis

Resuscitation Training Officer, Salford Royal Hospital

Mrs Sarah Wallace

Speech and Language Therapist, University Hospital of South Manchester & Royal College of Speech & Language Therapists

Ms Barbara Bonvento

Physiotherapist, University Hospital of South Manchester

Preface

This manual is a resource developed by the UK NTSP to help promote and facilitate the safe management of tracheostomies and laryngectomies. The scope includes hospital in-patient specialist areas, such as critical care, head and neck units and specialist wards, but is also applicable to more general wards, outpatient and community settings. The majority of the content is for adult patients, with a new paediatric chapter developed with colleagues from Great Ormond Street Hospital.

We have attempted to make the resource a 'one-stop shop' covering all aspects of tracheostomy and laryngectomy management by collecting together resources from surgical, anaesthetic, nursing, intensive care and allied health backgrounds, along with guidance from key national stakeholder organisations. These include the Difficult Airway Society, Intensive Care Society, the Royal College of Anaesthetists, ENT UK, British Association of Oral and Maxillofacial Surgeons, College of Emergency Medicine, Resuscitation Council UK, Royal College of Nursing, Royal College of Speech and Language Therapists, Association of Chartered Physiotherapists in Respiratory Care, British Laryngological Association, Faculty of Intensive Care Medicine, National Association of Laryngectomy Clubs and the National Patient Safety Agency.

We have also reviewed many local, regional, national and international guidelines, policies and resources during the preparation of this manual. Many such groups have previously developed excellent resources for the care of 'neck breathers', but these were often focused on specific areas of practice. We have also received many hundreds of comments on draft resources and further advice from around the world. We are grateful to the many individuals who have contributed to this project in this way and have acknowledged as many as possible where appropriate.

This unique document has been developed by consulting as widely as possible, across traditional professional boundaries using expertise and existing guidance from around the world. The manual attempts to pull together the different pieces of the jigsaw that already existed, as well as devising new resources where we felt they were needed. Previous work is referenced and accredited where appropriate, and we are grateful for the permissions that have been granted for use of other materials. This manual is supported by our website www.tracheostomy.org.uk, which contains

many new educational resources, e-learning packages and videos. We have included urls in the footnotes, where relevant, to the specific sections of the website and our resources.

This guidance is applicable for a novice first responder looking after a patient with a tracheostomy or laryngectomy for the first time, through to an airway expert secondary responder.

We hope you find these resources useful. Please contact us if you have any further comments or resources that you feel would add to this project. We are particularly interested to hear if the emergency algorithms have been used successfully.

Dr Brendan McGrath
Consultant in Anaesthesia & Intensive Care Medicine
University Hospital of South Manchester
Manchester, UK

Honorary Senior Lecturer
University of Manchester
University of Salford

On behalf of the Working Party of the National Tracheostomy Safety Project
www.tracheostomy.org.uk

Acknowledgements

This project would not have been possible without the valued time and contributions of a great many people. We have endeavoured to list as many as we can in this section. We have also been granted permission to use images, documents, videos and resources from many sources.

We are indebted to the following organisations and individuals for comments and advice on early versions of the manuscript and algorithms, and for their input into the wider resources and remit of the project:

Difficult Airway Society: Dr Ellen O'Sullivan (President); Dr Atul Kapilla (Secretary); Prof Jaideep Pandit (Scientific Officer); Dr Peter Groom (Treasurer) and Dr Andy Higgs

Royal College of Anaesthetists: Dr Peter Nightingale (President) and Dr Tim Cook (NAP advisor to the RCoA)

Intensive Care Society: Dr Simon Baudouin (Standards Committee chair); Dr Andrew Bodenham (ICS Tracheostomy Standards Author) and Dr Andrew Bentley (Council member) Also: Simon Mackenzie; Paul Murphy, Dominic Bell; Steve Bonner; Fiona Branch; Deborah Dawson; Paul Morgan; Simon Baudouin and Kevin Gunning

ENT UK: Mr Andrew McCombe (Honorary Secretary); Mr Vinidh Paleri; Mr Paul Pracy and Mr Richard Wight (Head and Neck Committee)

BAOMS: Prof Simon Rogers (Chair, Clinical Effectiveness Committee)

RCSLT: Mrs Sarah Wallace and Mrs Susan McGowan (Expert Advisors)

CSP: Mrs Cathy Sandsund (ACPRC Research Officer) and Mr David McWilliams (ACPRC Critical Care Champion)

RCN: Sr Rachel Binks (Chair, Critical Care Steering Committee)

CEM: Prof Jonathan Benger (Chair, Clinical Effectiveness Committee and Emergency Airway Lead)

NPSA: Mrs Joan Russell (Head of Patient Safety Anaesthesia and Surgery) and Mrs Fran Watts (Patient Safety Lead, Surgery)

Resuscitation Council UK: Dr Carl Gwinnutt; Dr Jerry Nolan and Dr Jasmeet Soar (on behalf of the Executive Committee)

British Association of Laryngology: Prof Martin Birchall and Mr Taran Tatla

With thanks to all Working Party members and contributors, especially:

Sr Sam Westwell, Nurse Consultant Critical Care, Salford Royal Hospitals FT

Dr Anna Perks, Consultant Anaesthetist, Salford Royal Hospitals FT

Dr Jane Eddleston, Consultant Intensivist, Central Manchester FT

Dr Bernard Foex, Consultant Intensivist, Central Manchester FT

Dr Irfan Chaudry, Consultant Intensivist, Royal Preston Hospital

Dr Ben Slater, Consultant in Anaesthesia & ICM, NHS Fife, Edinburgh

Sr Elaine Grainger, Critical Care Outreach, UHSM

CN Tim Baker, AICU Practice Educator, UHSM

Sr Jo Cooke, Tracheostomy Nurse Specialist, GOSH

Miss Michelle Wyatt, Consultant Paediatric ENT surgeon, GOSH

Dr Carl Gwinnutt, Resus Council UK

Dr Cath Roberts, Consultant in Emergency Medicine, Royal Preston Hospital

Dr Claire Moore, Consultant in Anaesthesia, UHSM

Dr Dan Nethercott, Consultant in Anaesthesia and ICM, Blackburn

Dr Harry Chan, Consultant in Anaesthesia and ICM, Wigan

Sr Helen Slattery, UHSM

Dr Iain Gall, Consultant in Anaesthesia, Central Manchester FT

Dr Jon Arnot Smith, Consultant Intensivist, Royal Bolton

NPSA expert reference group:

Prof Anthony Cheeseman (The Wellington Hospital, London)

Dr William Oldfield (Imperial College, London)

Prof Anthony Narula (St Mary's Hospital, London)

Mr Khalid Ghufoor (The Royal London Hospital)

Mr Guri Sandhu (Imperial College, London)

Mr Asit Arora (St Mary's Hospital, London)

Mrs Claudia Russell (Cambridge)

Lindsay Benjamin (St Mary's Hospital, London)

With thanks also to:

Mr Alan Ryan, National Programme Director, Heath Education England e-Learning for Healthcare (HEE e-LfH) for permission to use graphics and images developed with e-LfH, used in this manual.

Mr Nick Cleary, eLfH, for assistance with images and artwork, especially for the eLfH e-learning resources.

Mr Dev Chandramani & Mr Deepak Sharma from Boxsail for Website and SmartPhone App design. http://www.boxsail.co.uk

Special thanks to Emma McGrath, Ali Atkinson, Claire Moore, Damian Bates and all of our extended families for the support and assistance, childcare and facilitating all of the late nights that have made this project possible.

Competing interests

The NTSP has received funding from the Intensive Care Society (ICS) and assistance from the Royal College of Anaesthetists (RCoA) (allowed use of in-house programmers) specifically to contribute towards the e-learning for healthcare modules developed as part of this project.

The project has also received sponsorship from the following companies: Smiths-Medical (Portex), Cook, Kapitex, Ambu a-Scope, Olympus, Astellas Pharma and Pfizer. This sponsorship has specifically been used to reduce the cost of medical, nursing and allied health staff attending our tracheostomy safety courses and has not influenced the production or development of these resources. No individual or organisation has benefitted financially from this project.

Disclaimer

While this information has been collected and designed to help in clinical management, the authors do not accept any responsibility for any harm, loss or damage arising from actions or decisions based on the information contained within this publication, the associated website and materials. Ultimate responsibility for the treatment of patients and interpretation of these materials lies with the medical practitioner/user. The opinions expressed are those of the authors. The inclusion in this publication of material relating to a particular product or method does not amount to an endorsement of its value, quality or the claims made by its manufacturer. These guidelines should not constitute a minimum standard of practice nor should they be regarded as a substitute for good clinical judgement.

Every effort has been made by the authors to use materials and sources that are reliable and provide information that is compatible with the standards generally accepted at the time of publication. Because of the nature of medical practice, we recommend that the reader always consults current research and institutional policies before performing clinical procedures. The authors accept no responsibility for the persistence or accuracy of urls for external content referred to in this publication.

Contact details and further information

NTSP: www.tracheostomy.org.uk

ALSG: www.alsg.org

For details on ALSG courses, visit the website or contact:

Advanced Life Support Group
ALSG Centre for Training and Development
29-31 Ellesmere Street
Swinton, Manchester
M27 0LA
Tel +44 (0) 161 794 1999
Fax +44 (0) 161 794 9111
Email: enquiries@alsg.org

Updates

The material within this book will be updated on a 5-yearly cycle. However, practice and advice may change in the interim period. We will post any changes on the ALSG website, so we advise that you visit the website regularly to check for updates (www.alsg.org—go to the Tracheostomy page). The website will provide you with a new page to download and replace the existing page in your book.

Permission granted to reproduce for personal and educational use only. Commercial copying, hiring, lending or sale is prohibited.

The NTSP is acknowledged as the author of this manual.

Executive summary key recommendations

This section details the main points of this manual. Further explanation can be found in the relevant sections. Many of the recommendations originate from the National Patient Safety Agency (NPSA) multi-professional external reference group, comprising representatives from key 'National Bodies' and expert clinicians. Recommendations are also included from Irish and Scottish best practice circulars.

Key issue

A patient with a tracheostomy or laryngectomy is at risk of death or harm if inappropriate or inadequate care is provided. This patient group requires airway devices to be safely inserted, securely positioned and appropriately cared for, in order to continue to provide the patient with a patent airway. Failure to do so may lead to a displaced or blocked tube, which, if not dealt with immediately, may be fatal within minutes.

Action

1. Leadership

a. Identify a clinical lead in each National Health Service (NHS) Trust or institution to coordinate the management of patients with tracheostomies.

b. Trusts must have a local policy in place, which outlines the expected management of patients with a tracheostomy or laryngectomy.

2. Environment

a. Identify appropriate environments in which to manage patients with tracheostomies and laryngectomies.

b. Identify a comprehensive risk assessment of the patient that is agreed upon locally to determine the dependency of the patient, the level of the observation and visibility required.

c. The frequency of risk assessment should be determined by the patient's condition, clinical environment, staffing levels, skills and competence. The risk assessment must be retained in the patient record as appropriate.

d. Trusts that are unable to develop systems to reduce risks effectively in all clinical areas should consider identifying designated areas where the risks are reduced.

3. Equipment

a. Equipment for the management of the tracheostomy including suction should be kept near the patient at all times.

b. Equipment should be checked, at a minimum, on a daily basis.

c. Emergency equipment must remain immediately available at the bedside and accompany the patients if they leave their base location.

d. All tracheostomy tubes used should have a removable inner cannula. Exceptions to this must be clearly documented in the patient's medical record and a date for review determined.

e. The inner cannula should be regularly checked and cleaned, as this greatly reduces the risk of a tracheostomy tube becoming blocked.

4. Staffing

a. Patients with tracheostomies must be cared for by staff who have been appropriately trained and are currently considered competent in tracheostomy care.

b. Staff must be able to access appropriate training and support in order to deliver appropriate care, identify risk factors and initiate management of complications. All training received should be documented.

c. Trusts must ensure that training programmes are in accordance with best evidence-based guidelines on the management of a tracheostomy.

d. Tracheostomy training and support is locally coordinated by the clinical lead.

e. Staff escorting the patient outside of the clinical area must be competent in dealing with suctioning and in managing a tracheostomy emergency.

5. Knowledge

a. All staff caring for patients with tracheostomies and laryngectomies must be competent to do so, both in routine care and in the emergency situation. This includes designated wards and clinical areas, and also acute services, such as acute medical units and emergency departments, that may be expected to see tracheostomy complications.

b. These recommendations can be extended to carers outside of the hospital environment, in nursing homes, patients' own homes and to those responding to patients who are community based.

c. Emergency algorithms should be taught, displayed and used to manage tracheostomy or laryngectomy emergencies.

d. Essential information can be displayed at the bedside to assist in managing an emergency at which the attending staff may not know the history of the patient.

6. Information and benchmarking

a. Collect and analyse data on your institution's performance. This can range from keeping an adverse incident record or contributing to a large database.

b. International Quality Improvement Collaboratives exist to improve care by rapidly disseminating best practice initiatives. Data may be submitted to track improvements in care and to allow benchmarking with similar institutions.

c. The Global Tracheostomy Collaborative shares the same ambitions as the NTSP and their website details information for institutions wishing to join the collaborative. (www.globaltrach.org)

Chapter 1

How the NTSP resources were developed

These NTSP resources are for medical, nursing, allied health staff and students. There are resources for patients available separately.

This project started with a group of four Intensive Care Doctors working in Manchester, UK, who wanted to improve the management of patients with tracheostomies. We had identified recurrent themes common to tracheostomy and laryngectomy emergencies and recognised that in order to improve care, educational resources and innovative ways to teach them were urgently required. We initially sought the help of other colleagues in Critical Care, Anaesthesia, ENT surgery and maxillofacial surgery, forming a multi-disciplinary, multi-site working party to develop these resources. This group grew to incorporate input from nursing, physiotherapy and speech therapy colleagues, along with patients and patient groups and other medical and allied health professionals. A short video describing the origins of the project can be viewed at the url provided in the footnote.[1]

We have focused our attentions in two key areas: the emergency management algorithms and improving routine care by developing educational resources aimed at preventing neck-breathing patients developing life-threatening emergencies.

We developed and tested our emergency guidance with high-fidelity simulators using specific scenarios to ensure that nursing staff, doctors and allied health professionals could follow our algorithms. We have also introduced this guidance in a number of different trusts in the UK and developed the project incorporating multi-site, multi-speciality peer review and feedback.

The resources are supported by an extensive e-learning package, developed in partnership with the UK Department of Health's e-Learning for Healthcare project and the Royal College of Anaesthetist's e-Learning in Anaesthesia project. We have provided as much information as possible in video, diagram and schematic format, with many links from the text of this manual direct to YouTube videos and the resources of our website.[2] This was in response to feedback received when we started to disseminate this information more widely. A lot of tracheostomy-related procedures

are best learned when you can actually see someone doing it – either at the bedside locally, or via some of the videos we have provided. The resources in the manual have arisen from extensive collaboration between local, national and international stakeholder groups and have built on previously published guidelines, resources and expert opinion. We saw our role as putting together the individual pieces of the jigsaw that often existed in respect to specialised areas of tracheostomy and laryngectomy care.

The various resources have been peer reviewed by a number of different processes, including open peer review of draft resources posted on our website and the websites of a number of partner organisations. The emergency guidelines, algorithms, bedhead signs and supporting manuscript have been endorsed by the Difficult Airway Society, Intensive Care Society, the Royal College of Anaesthetists, ENT UK, British Association of Oral and Maxillofacial Surgeons, College of Emergency Medicine, Resuscitation Council UK, Royal College of Nursing, Royal College of Speech and Language Therapists, Association of Chartered Physiotherapists in Respiratory Care, National Association of Laryngectomy Clubs and the National Patient Safety Agency. There have also been contributions from The British Laryngological Association and the Faculty of Intensive Care Medicine. The NTSP manual has been reviewed by many of these groups, either formally or informally, and also revised by a multi-disciplinary NTSP editorial board. Finally, the e-Learning for Healthcare resources have been reviewed by e-Learning Anaesthesia at the Royal College of Anaesthetists.

Full details of the literature, review process and development of these guidelines are described in McGrath et al.'s (2012) manuscript[3] in *Anaesthesia*.

[1] http://www.youtube.com/watch?v=yFmbDca4Dxc

[2] http://www.tracheostomy.org.uk/

[3] http://www.ncbi.nlm.nih.gov/pubmed?term=Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies.

Chapter 2

What is a tracheostomy? What is a laryngectomy?

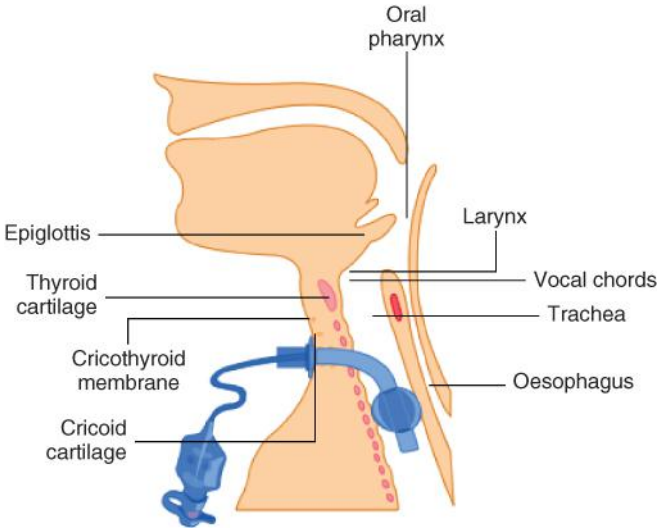
What is a tracheostomy?

Tracheostomies are performed in head and neck surgical practice, with over 5000 procedures performed yearly in England. We estimate around 10 000–15 000 percutaneous tracheostomies are performed each year in England's critical care units, although the actual figure is currently unknown. Tracheostomies are also becoming more commonplace on the general wards of the hospital. This is partly due to pressures on intensive care beds and the increasing drive to de-escalate care quickly, along with increasing numbers of patients benefiting from temporary tracheostomies. These groups include those with chronic respiratory or neurological problems. Increasing numbers of patients with tracheostomies are being cared for on wards outside the specialist ward [typically ENT or maxillofacial wards, or sometimes neurosurgical or neurology wards] or critical care infrastructure.

This has implications for the safety of patients who may be cared for on wards without the necessary competencies and experience to manage this challenging cohort and local measures need to be in place to ensure that safe routine and emergency care can be provided. This manual has evolved to provide information to those caring for patients with temporary or permanent tracheostomies, either regularly or occasionally. It aims to provide basic background information and the rationale for tracheostomy care (Figure 2.1).

Figure 2.1 A sagittal section through the upper airway anatomy showing a tracheostomy *in situ*.

Reproduced with permission of HEE eLfH.



What problems can occur with tracheostomies?

While tracheostomies are increasingly commonplace, patient safety incidents associated with their use are unfortunately increasing. Over 1700 incidents were reported to the NPSA between 1 January 2005 and 31 December 2008, including over 30 deaths. We know from research with the NPSA that when a clinical incident occurs relating to a tracheostomy, the chance of some harm occurring is between 60% and 70%, depending on the location in which that the patient is being cared for [see links to these abstracts for NPSA papers in Thomas and McGrath (2009) and McGrath and Thomas (2010)].

Incidents may be classified as

- incidents at the time of performing the tracheostomy (e.g. airway loss; damage to adjacent structures; bleeding);
- blockage or displacement of the tracheostomy tube after placement;
- equipment incidents (usually lack of equipment or inappropriate use);
- competency (skills and knowledge) incidents;

- infrastructure (staffing and location) incidents;
- late complications (e.g. tracheomalacia, stenosis, infection of stoma).

The majority of these incidents are due to the same recurring themes and the resources we have developed as part of this project are specifically aimed at addressing these.

There is more detail on tracheostomy and laryngectomy problems in the complication, red flags and emergency management section.

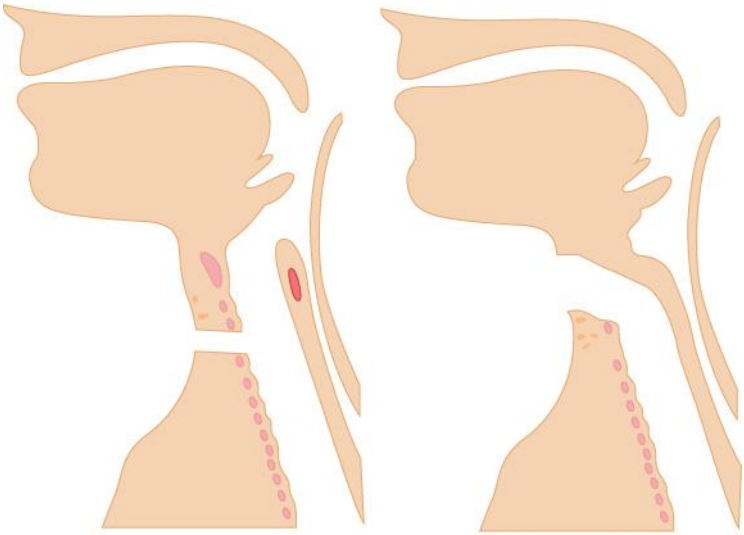
What is a laryngectomy?

The larynx (voice box) can be involved in oral, pharyngeal or laryngeal carcinomas. These are usually squamous cell carcinomas and can be treated by radiotherapy and surgery, depending on the site and the general condition of the patient. Surgical resection of the tongue base or epiglottis may not necessarily involve removal of the larynx and is sometimes referred to as a *supraglottic laryngectomy*. It is sometimes possible to resect only one half of the larynx for localised disease with a *hemilaryngectomy*. However, if a *total laryngectomy* is required, this involves complete surgical removal of the larynx, which disconnects the upper airway (nose and mouth) from the lungs. This is a permanent and irreversible procedure (although partial laryngectomies are possible). The trachea is transected (cut) and then the open end is stitched onto the front of the neck. Once this has been performed, the patient will never be able to breathe or be oxygenated or ventilated through the upper airway again. An animation showing the difference between a tracheostomy and a laryngectomy[1] can be found in the link provided in the footnote.

As shown in Figure 2.2, a tracheostomy still provides a *potentially* patent upper airway. Remember though that tracheostomies are often performed because of actual or anticipated difficulty with the upper airway, so upper airway patency cannot be guaranteed.

Figure 2.2 The differing anatomy of a tracheostomy (a) and laryngectomy (b).

Reproduced with permission of HEE eLfH.



What problems can occur with laryngectomies?

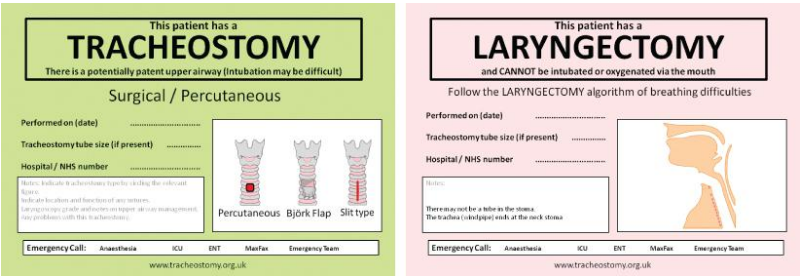
The laryngectomy patient has had the normal upper airway humidification mechanisms bypassed, in the same way as a tracheostomy patient. They are at risk of blockage of the trachea with secretions or blood. The airway is often more secure than with a temporary tracheostomy, as the trachea is stitched onto the front of the neck. It can still become compromised, however, particularly within a few days of surgery. Laryngectomy stomas are usually simple open stomas without a tube inserted. There are a variety of covers, valves and humidification devices available, which can make distinguishing between a tracheostomy and laryngectomy very difficult. Tubes are sometimes inserted into laryngectomy stomas, especially when they have just been created; the patient needs invasive ventilation or requires repeated suctioning. Tracheostomy tubes are usually used, although specific laryngectomy tubes are available. The use of bedhead signs to alert staff that a patient does not have an upper airway is

extremely useful, especially when the patient cannot tell you because of acute illness or not being able to talk following a laryngectomy.

One of the commonest problems with a laryngectomy, particularly in an emergency, is that responders fail to appreciate that the patient has actually had the larynx removed. It can be difficult to tell the difference at the bedside between a laryngectomy and a surgical tracheostomy, particularly close to major surgery. There are many incident reports of patients, following a laryngectomy, who are mistakenly given oxygen via the face or who have had attempts at managing their upper airway fail because there is no connection between the face and lungs. Likewise, we know of situations where following radical head and neck surgery, carers have failed to manage a patient's upper airway after *assuming* that they had had a laryngectomy when, in fact, they had not. We have developed colour-coded bedhead signs and algorithms to immediately distinguish laryngectomies from tracheostomies, as recommended by the NPSA and ICS. These are discussed in detail in the emergency algorithm section.

The green bedhead sign, depicted in Figure 2.3, is paired with the green emergency algorithms and indicates a (potentially) patent upper airway that can be used in an emergency. The red bedhead sign is paired with the red laryngectomy algorithm. The signs also allow details of the nature and date of the tracheostomy to be recorded, along with details of the airway, and whom to call (and how) in an emergency (Figure 2.3).

Figure 2.3 Green and red bedhead signs designed to clarify a patient's airway condition and support the emergency management.



[1] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Basics.htm

Chapter 3

Why and how a tracheostomy is performed

Indications for a tracheostomy

The classical indication for a tracheostomy is upper airway obstruction and this is why the first recorded tracheostomies were performed. However, in modern medical practice, the indications have widened both for temporary and permanent tracheostomy. Indications can be considered as

- to secure and maintain a patent airway in upper airway obstruction (actual or potential);
- to secure and maintain a safe airway in patients with injuries to the face, head or neck and following certain types of surgery to the head and neck;
- to facilitate the removal of bronchial secretions where there is poor cough effort with sputum retention;
- in an attempt to protect the airway of patients who are at high risk of aspiration, that is, patients with incompetent laryngeal and tongue movement on swallowing, for example, neuromuscular disorders, unconsciousness, head injuries and stroke.
- to enable long-term mechanical ventilation of patients, either in an acute intensive care unit (ICU) setting or sometimes chronically in hospitals or in the community;
- to facilitate weaning from artificial ventilation in acute respiratory failure and prolonged ventilation.

Because of the nature of the underlying medical conditions that often lead to a tracheostomy, patients who receive a tracheostomy often have poor survival prospects. A review of over 23 000 American inpatient records where a tracheostomy was performed demonstrated that only 80% survived to hospital discharge, with as few as 60% surviving if they had significant co-morbidities (Shah et al., 2012).

There is no convincing data that can guide clinicians as to the timing of a tracheostomy. For specific circumstances, such as extensive elective head and neck surgery, the decision is straightforward. However, balancing the risks of managing an airway with prolonged endotracheal tube (ETT) intubation versus the risks of tracheostomy (procedural and post-placement) is difficult and must be made on an individual basis (Box 3.1).

Box 3.1 Risks of prolonged ETT and tracheostomy

Risks of prolonged ETT

- Unpleasant to tolerate
- Prolonged sedation required
- Difficult to reinstitute respiratory support without re-intubation
- Upper airway trauma
- Damage to vocal cords
- Breaches larynx and risks aspiration
- Blockage and displacement

Risks of tracheostomy

- Invasive procedure
- Bleeding and airway loss during procedure
- Stoma infection or breakdown
- Scarring, tracheomalacia and stenosis
- Blockage and displacement
- Damage to adjacent structure

Anatomy relevant to tracheostomy

A tracheostomy is an artificial opening made into the trachea through the neck. This may be temporary or permanent. A tracheostomy tube is usually inserted, providing a patent opening. The tube enables airflow to enter the trachea and lungs directly, bypassing the nose, pharynx and larynx.

There are a variety of tracheostomy techniques but they all aim to enter the trachea around the gap between the second and third tracheal rings. Emergency access to the airway can be achieved through the relatively avascular cricothyroid membrane. This is reasonably anterior in the neck, close to the surface and can be identified by feeling for the ‘dent’ below the ‘Adam’s apple' or thyroid cartilage (Figures 3.1 and 3.2). The further down the neck towards the chest you palpate, the deeper into the neck the trachea goes. In some patients it is difficult to feel the trachea at all.

Figure 3.1 Anterior tracheal anatomy showing tracheostomy site.

Reproduced with permission of HEE eLfH.

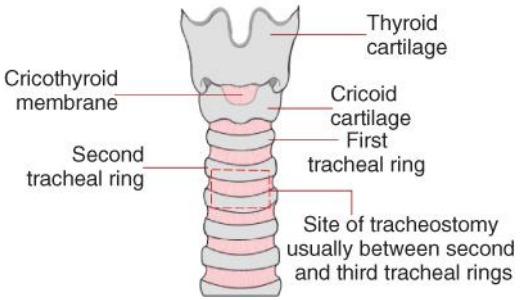
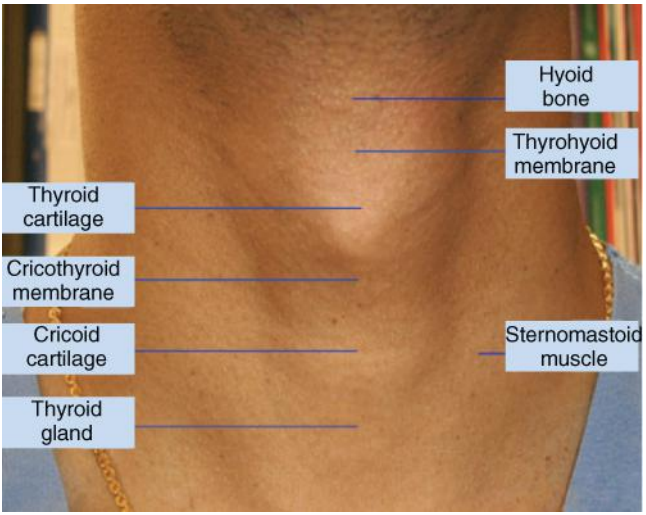


Figure 3.2 Surface anatomy of the anterior neck.

Reproduced with permission of HEE eLfH.



There are many important structures that lie in the neck in close proximity to the trachea (Figure 3.3). These can be damaged, or cause haemorrhage, while performing a tracheostomy.

Figure 3.3 Important structures surrounding potential tracheostomy sites.

Reproduced with permission of HEE eLfH.

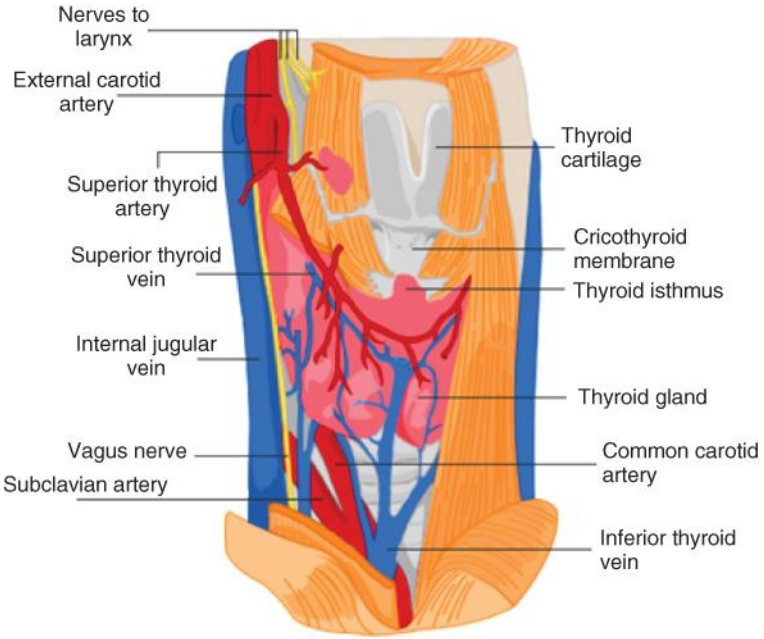
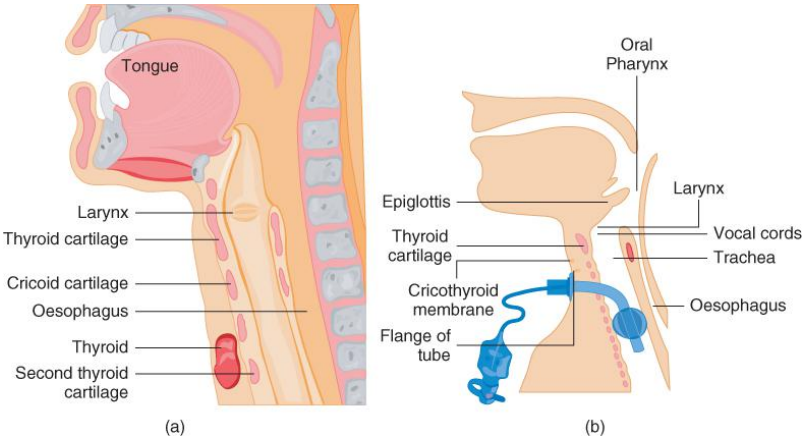


Figure 3.3 highlights some of the important structures relevant to tracheostomy. These are shown in the lateral views in Figure 3.4(a) and (b). The thyroid isthmus is often resected during a surgical tracheostomy, but this is not possible during a percutaneous procedure. Similarly, bleeding vessels are more amenable to ligation and diathermy using a surgical technique. The percutaneous technique probably causes less tissue trauma and may make bleeding less likely, but the only way to stop any resultant bleeding is by applying pressure. This can be externally applied or caused by a tamponading effect from the tube within the newly dilated tissues.

Figure 3.4 Lateral view of the upper airway (a) without and (b) with a tracheostomy *in situ*.

Reproduced with permission of HEE eLfH.



Note the position of the flange of the tracheostomy tube [Figure 3.4(b)]. This should be flush with the skin on the front of the neck. In large or obese patients, it can be seen that the distance between the skin and the trachea can be significant. This may require specialist tracheostomy tubes to ensure a safe and correct 'fit'.

The anatomy relevant for laryngectomy is similar, except that the result is an end stoma: the trachea terminates at the front of the neck and is no longer in continuity with the upper airways. Figure 3.5(a) shows a patient with a tracheostomy tube in a tracheostomy stoma, while Figure 3.5(b) shows a newly created, open laryngectomy stoma, with no tube *in situ*. It can be very difficult to tell the difference, especially if you are not familiar with laryngectomies. Bedhead signs have an important role here.

Figure 3.5 Patients with (a) a tracheostomy tube in a tracheostomy stoma and (b) an open laryngectomy stoma with no tube *in situ*.

(a)

(b)

Types of tracheostomy

Tracheostomy may be temporary or long term/permanent, and may be performed electively or as an emergency procedure. They may also be classified by their method of initial insertion – either surgical or percutaneous.

Temporary

Temporary tracheostomies will be performed when patients require short-term respiratory support or cannot maintain the patency of their own airway. They can also provide a degree of 'protection' of the airways against aspiration if the swallowing or neurological control mechanisms of the larynx or pharynx are damaged (commonly in head injuries or neurological diseases). Certain maxillofacial or ENT surgical procedures require a temporary tracheostomy to facilitate the procedure. These tubes will be removed if and when the patient recovers.

Long term/permanent

Long term/permanent tracheostomies are used when the underlying condition is chronic, permanent or progressive. This includes carcinoma of the naso-oropharynx or larynx. Dependent on the stage of the disease,

either a tracheostomy or a laryngectomy will be performed. Some patients need chronic respiratory support or long-term airway protection and this requires a long-term/permanent tracheostomy.

Techniques for inserting a tracheostomy

Introduction

Tracheostomy is one of the oldest recorded surgical procedures, depicted on Egyptian tablets dated from around 3600 bc. The earliest publication is in the Rigveda, a sacred Hindu book published around 2000 bc. Asclepiades of Persia (100 bc) and Alexander the Great (350 bc) are described as early practitioners, with other sporadic anecdotal accounts, including Hippocrates concluding that they were dangerous.

Antonio Musa Brasavola, an Italian physician, is widely credited with performing the first (well-documented) successful tracheotomy (Figure 3.6). He published his account in 1546. The patient, who suffered from a laryngeal abscess, recovered from the procedure. The same cannot be said for George Washington who died in 1799, probably from upper airway obstruction due to epiglottitis or an abscess. His physicians considered a tracheostomy but were reportedly reluctant to 'have a go' on someone so eminent! The famous surgeon Chevalier Jackson described modification to the procedure in 1909, making it safe to perform with markedly reduced long-term complications, especially for children. A video can be viewed here (http://vimeo.com/38704374) (Figure 3.7) showing Chevalier Jackson demonstrating a tracheostomy on a rag doll in his car, around 1925.

Figure 3.6 Antonio Musa Brasavola. Courtesy of the US National Library of Medicine.

RITRATTI DI MEDICI E NATURALISTI ITALIANI DAL SECOLO XV° AL XVIII°
ANTONIO MVSA BRASAVOLA
dalla litografia del Farina pubblicata dal Petrucci nelle sue vite di ferraresi celebri.

Figure 3.7 Chevalier Jackson demonstrating a tracheostomy on a rag doll in his car.

The 1952 polio epidemic saw tracheostomies used in the first ICUs in Copenhagen, Denmark (Figure 3.8). Bjørn Ibsen pioneered this technique and thus allowed positive pressure ventilation to be delivered to patients and thereby reduced mortality from bulbar polio from around 85% to less than 15%.

Figure 3.8 A patient from the Copenhagen polio epidemic being ventilated via a tracheostomy.

Lassen (1953). Reproduced with permission of Elsevier.

Procedures, techniques, anaesthesia and devices have evolved significantly since 1952. There are two main techniques used to perform a tracheostomy: surgical or percutaneous.

Surgical tracheostomy

This technique is usually carried out in an operating theatre where conditions are sterile and lighting is good. It is possible to perform a surgical tracheostomy at the bedside in the ICU. General anaesthesia is commonly used; however, surgical tracheostomies can also be carried out under local anaesthetic. A surgical opening is made into the skin and the tissues of the neck are dissected down to the trachea. The trachea is entered by forming a slit or a window into which a tube is placed. The tube may then be sutured to the skin and/or secured with cloth ties or a holder.

Surgical tracheostomies (Figure 3.9) may be formed as part of ENT or maxillofacial surgical procedures, usually during face and neck dissections for tumour removal. Importantly, in procedures where surgical removal of the larynx is undertaken, a laryngectomy stoma is created. This means that there is no connection from the mouth or nose to the trachea. Detailed descriptions of surgical techniques are beyond the scope of this manual.

Figure 3.9 A surgical tracheostomy.

Types of surgical tracheostomy

The incision in the anterior tracheal wall may be one of the following.

1. **Horizontal slit**: A horizontal or T-shaped tracheal opening through the membrane between the second and third or third and fourth tracheal rings [Figure 3.10(a)]. With this incision, a silk stay suture can be placed through the tracheal wall on each side and taped to the neck skin on either side. This facilitates tube replacement by pulling the trachea anteriorly and widening the opening should the tube dislodge in the immediate postoperative period. These sutures are removed after the first tracheostomy tube change, usually 5–7 days postoperatively once the newly formed tract from the skin to the trachea becomes more established.

2. **Window**: Removal of small anterior portions of the tracheal rings can create a more permanent stoma, like the 'window' shown in Figure 3.10(b).

3. **Vertical slit**: A U- or H-shaped tracheal opening can be made and the tracheal flaps can be tacked to skin edges with absorbable sutures to create a semi-permanent stoma [Figure 3.10(c)]. Sutures

can be placed in each tracheal flap and taped to the chest and neck skin, facilitating replacement of a displaced tube in postoperative care [Figure 3.10(d)]. Pulling on these sutures widens the tracheal opening.

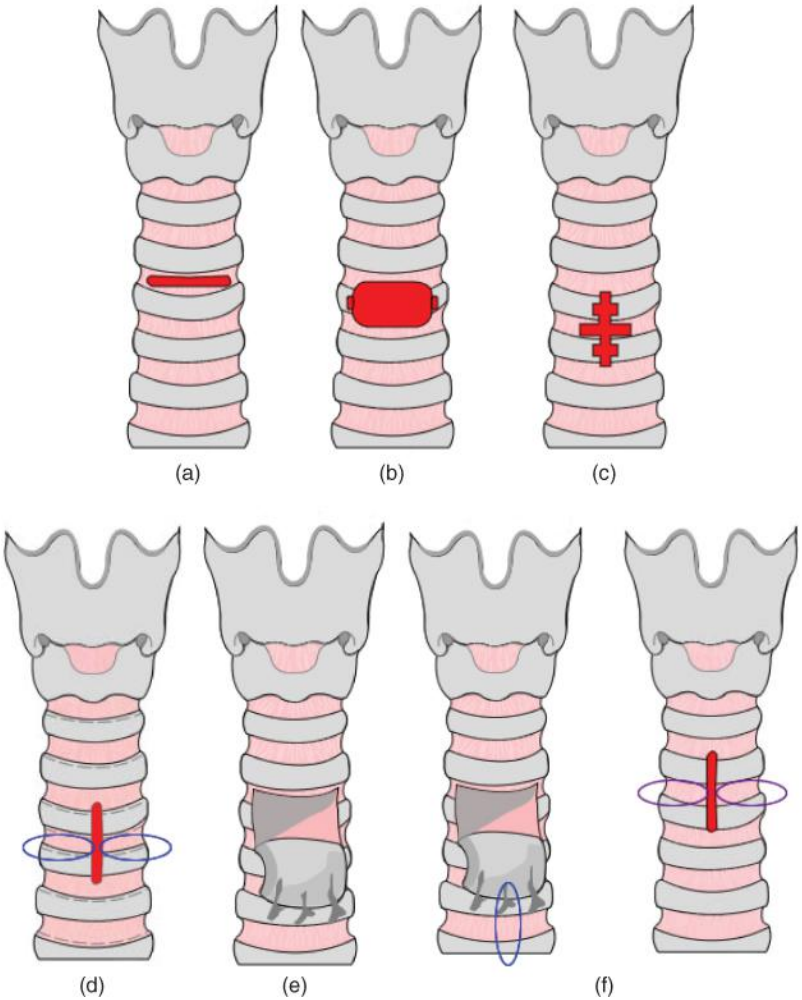
4. Most modern adult surgical tracheostomies will be performed in this way, with the sutures remaining for approximately 1 week until the tract is formed.

5. Björk flap: A different type of surgical tracheostomy is the Björk flap where a 'ramp' of trachea is sutured to the skin, which allows easier replacement of tracheostomy tubes [Figure 3.10(e)]. There may be a suture to the skin here too, but this is to hold the 'ramp' in place, rather than to be used to elevate the trachea for a tracheostomy tube change. If Björk flap sutures are pulled, they may tear the 'ramp' and occlude the stoma. Björk flap tracheostomies are not commonly performed, but if they are done in your hospital, you need to know what the bits of suture coming out of the stoma will do when pulled!

6. Sutures: Figure 3.10(f) shows a Björk flap with a 'flap suture' to the skin (vertical oval) and slit-type tracheostomy with two stay sutures (horizontal ovals) to the skin. Sutures may be at the top and bottom of the incision, too. These can be used to manipulate the trachea.

Figure 3.10 Types of surgical tracheostomy.

Reproduced with permission of HEE eLfH.



Percutaneous tracheostomy

This is the most commonly used technique in critical care as it is simple, relatively quick and can be performed at the bedside using anaesthetic sedation and local anaesthetic (Figure 3.11). Moving critically ill patients to the operating theatre can be challenging, so a safe, bedside procedure

often makes this the technique of choice in the ICU. The procedure involves the insertion of a needle through the neck into the trachea followed by a guide wire through the needle. The needle is removed and the tract made gradually wider by inserting a series of progressively larger dilators over the wire until the stoma is large enough to fit a suitable tube (Seldinger technique, Figures 3.12 and 3.13). The tube is then secured by cloth ties, sutures or a holder. The urls of the videos of a percutaneous tracheostomy insertion are present within the parentheses: Video 1 (http://www.medicalvideos.us/videos/559/), Video 2 (http://www.youtube.com/watch?v=SloXwGG2n-Q), Video 3 (http://www.youtube.com/watch?v=PhasybkUrzk).

Figure 3.11 Percutaneous tracheostomy dilator.

Figure 3.12 Percutaneous tracheostomy insertion into a model via the Seldinger technique.

Figure 3.13 Percutaneous tracheostomy kit.

There is less dissection and cutting than with a surgical technique and this may cause less tissue trauma and bleeding. The tissues are stretched or dilated. However, the only way to stop any bleeding if it does occur is via the tamponading effect of the tube in the stretched tract. Most centres will opt for a surgical tracheostomy if a patient has bleeding problems or a large vessel near the puncture site, as this allows more options for controlling potential bleeding (diathermy, ligation). Some patients do not have an easily palpable trachea. A surgical approach may be safer for these patients also. It is possible to perform hybrid techniques where a

small amount of blunt dissection is performed prior to puncturing the trachea with a percutaneous set, or following formal surgical exposure, a percutaneous set is used to enter the trachea if the trachea is difficult to access.

To ensure correct needle placement within the trachea, the procedure is often guided by a suitable fibreoptic endoscope inserted into the airway. This technique has a number of advantages.

1. Confirmation of an appropriate entry point in the anterior trachea. Between 11 and 1 o'clock is ideal, although the closer to 12 o'clock, the better (Figures 3.14–3.16). Figures 3.15 and 3.16 show the needle visualised entering the trachea as viewed from inside the ETT.

2. It confirms appropriate entry site between second and third tracheal rings. May be able to guide the needle to reduce the risk of tracheal ring fracture.

3. It ensures that the needle does not pass through the posterior tracheal wall, risking paratracheal or oesophageal insertion.

4. It ensures that the guide wire is appropriately placed.

5. There is confirmation of eventual successful placement of the tracheostomy tube within the tracheal lumen.

6. It allows aspiration of blood promptly from the airway.

Figure 3.14 Endoscopic view of the trachea depicting clock positions to guide needle placement.

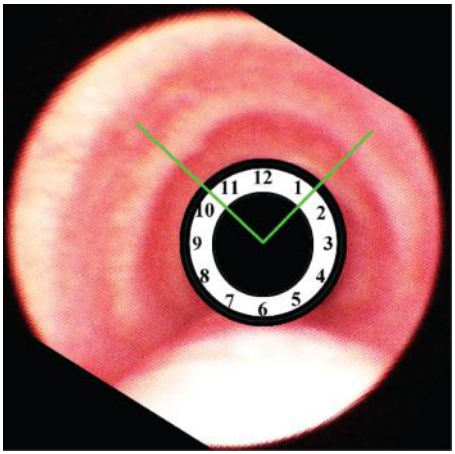


Figure 3.15 Correct placement of a needle and guide wire within the trachea.

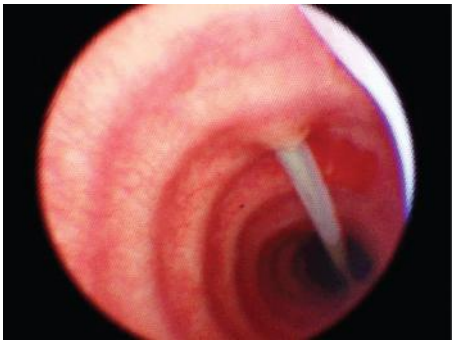
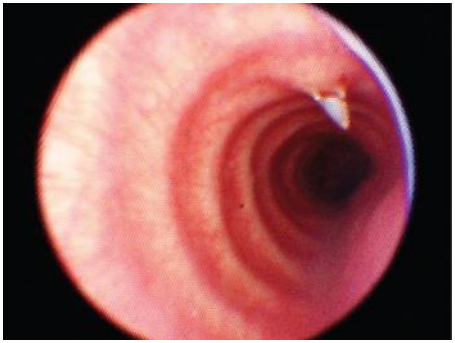


Figure 3.16 This puncture site is probably too lateral (towards 3 o'clock).



The images depicted in Figures 3.15 and 3.16 are both slightly rotated, with the true posterior (back) wall of the trachea lying in the bottom right-hand corner of each image.

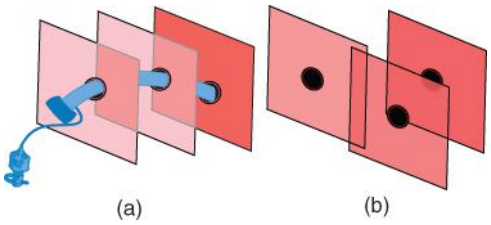
Introducing a bronchoscope into the airway does have its drawbacks. Depending on the size of the endoscope, an ETT of at least 7 mm internal diameter is usually required. This does not leave much room for ventilation and a degree of hypoventilation can be expected during the procedure. There is also the risk of damaging the endoscope during initial puncture of the trachea, although disposable endoscopes, which may address part of this problem, are now available.

A big difference with percutaneous tracheostomies in the first few days after the stoma is created is that the tract will take 7–10 days to mature,

compared with 2–4 days for a surgical tracheostomy. If a tracheostomy tube becomes displaced in this early period, the tissues are likely to 'spring' back into their original places, whereas the cut and sutured surgical tract is more likely to remain patent. This has implications for attempting to reinsert a new tracheostomy tube into a newly created percutaneous stoma. Despite the wealth of literature and claims about the various benefits of one technique over another, most clinicians from all specialties will agree that after the first week or so, what you have is a tracheostomy stoma and it does not really matter how it was formed. Better follow up of tracheostomies in the future may reveal subtle differences.

Figure 3.17 demonstrates how once a percutaneously inserted tracheostomy tube becomes displaced, the recently dilated tissues can 'spring' into their original positions, making reinsertion difficult.

Figure 3.17 Tissue alignment (a) with a tracheostomy tube *in situ* and (b) following tube removal.



Performing a tracheostomy

Preparation

Whatever the technique, preparation is essentially the same. Checklists can reduce the potential for performing the wrong procedure on the wrong patient at the wrong time, and should be used. Consent can be difficult in patients who lack capacity, either through chronic or critical illness. Ideally, documented discussions about the risks and benefits of

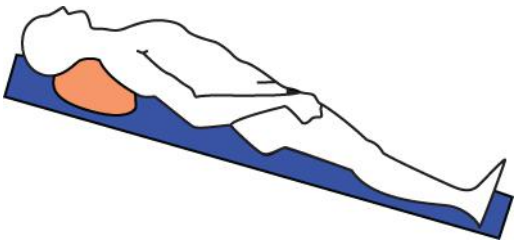
tracheostomy should take place whilst capacity remains, although this can be difficult in this cohort.

Review recent blood results and the drug regimen to ensure that clotting indices are within acceptable limits and that the patient has not received anti-coagulant medication. It is important to assemble the key personnel and equipment that will be required before commencing the procedure. As with all airway interventions, unexpected and time-critical complications may occur at any time. Critical care patients who are dependent on high fractions of inspired oxygen or high ventilation pressures are less likely to tolerate the hypoventilation and de-recruitment that inevitably occurs during a tracheostomy. Careful assessment of individual risks should be undertaken.

Positioning

Access to the patient's trachea can be made easier by positioning the patient appropriately, to bring the trachea more anteriorly in the neck. Care must be taken with patients who have a potentially instable neck or raised intra-cranial pressure. Pillows or support behind the shoulders will allow the neck to extend, as shown in Figure 3.18.

Figure 3.18 Neck extension and bed tilt.



Tilting the whole bed or operating table will drain neck veins and may reduce bleeding (Figure 3.18). The patient should be positioned at the side of the bed nearest the operator, with the head, neck and torso aligned to ensure that the midline is easy to identify. Finally, appropriate lighting should be used, especially for surgical procedures.

Anaesthetic considerations

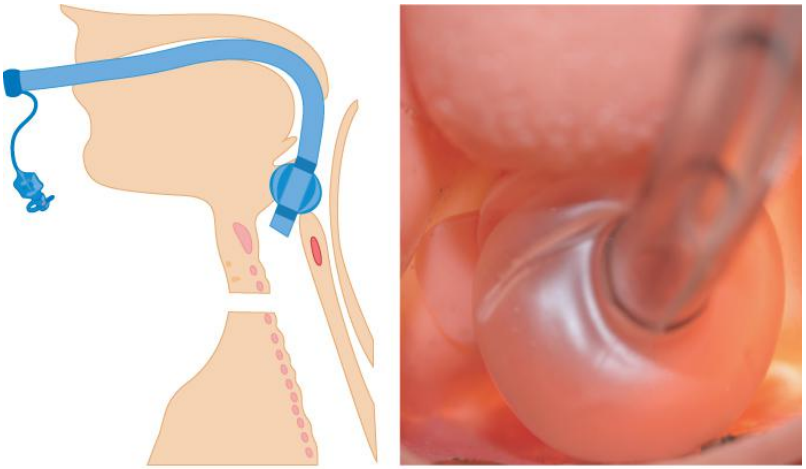
Tracheostomy may be performed under local anaesthesia alone. This usually includes a vasoconstrictor, such as adrenaline, to reduce bleeding. If the patient has impending upper airway obstruction, positioning may be very difficult, as the patient is likely to be distressed. Sedation should be avoided if possible in an attempt to maintain the patency of the upper airway.

If the patient is already ventilated, then some form of airway management will have occurred already, although this may not be definitive. A suitable intravenous sedative and analgesic combination should be administered and a neuromuscular blocking agent is usual. Tracheostomy is stimulating and significant doses of short-acting opiates and hypnotics are often required. These should be titrated carefully in the critically ill.

The upper airway can be managed with a simple facemask, supraglottic airway device (such as laryngeal mask airway, LMA) or more usually ETT (Figure 3.19). For percutaneous procedures, a suitable endoscope is usually employed to visualise entry of the needle into the trachea. This may necessitate changing of the current airway device (e.g. to a larger diameter ETT). An ETT will need to be withdrawn from the surgical field prior to tracheal incision and insertion of the tracheostomy tube. All airway manipulations are more difficult with the neck extended; therefore, experienced personnel with the appropriate difficult airway equipment should manage the upper airway. It is always prudent to perform direct laryngoscopy once the patient is in the position for the tracheostomy to view the airway. Remove any secretions above the tracheal cuff prior to deflating or manipulating the ETT. Gastric feed will also need to be stopped and aspirated prior to planned airway manipulations as per local guidelines. Figure 3.19 shows direct laryngoscopy, allowing ETT manipulation. The tube is usually withdrawn until the cuff sits above the vocal cords (Figure 3.20). The tube is now very precarious and care must be taken to ensure it remains in position, especially while performing endoscopy.

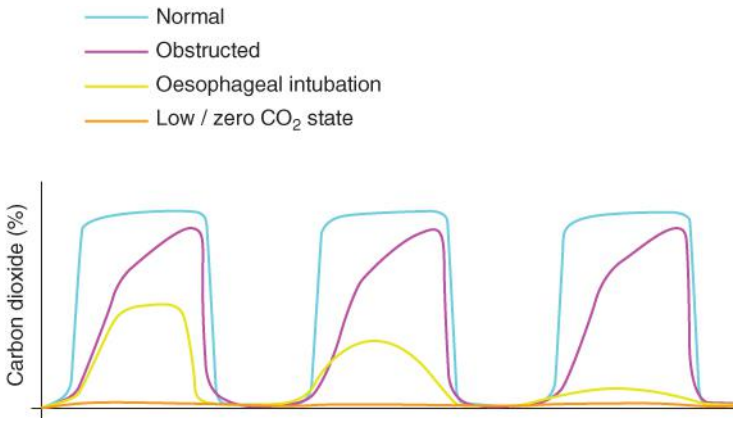
Figure 3.19 Securing the upper airway with an endotracheal tube via direct laryngoscopy.

Figure 3.20 Positioning the endotracheal tube in preparation for a percutaneous tracheostomy.



Routine monitoring utilising **capnography** is essential for any airway manipulation. Capnography will give immediate information about tube displacement from the upper airway and will confirm correct placement and adequate ventilation when the tracheostomy tube is inserted (Figure 3.21).

Figure 3.21 Capnography traces reflecting normal, obstructed, tube misplacement and low CO_2 states.



Finally, it is usual to pre-oxygenate the patient prior to any airway manipulations. This may be difficult in the critically ill, but increasing ventilation times and pressures, along with the inspired fraction of oxygen will offer a degree of protection against the hypoxia that may rapidly develop when ventilation is interrupted or compromised during manipulation of the airway devices.

Because of the potential problems with both anaesthetising for and performing a tracheostomy, practice on a suitable simulator is advocated before undertaking supervised practice with patients.

Physiological changes with a tracheostomy

As well as changing the airway anatomy, the airway physiology is altered when a patient has a tracheostomy inserted. Depending on the type of tube and presence of a cuff, the upper airway may be isolated completely. The tracheostomy will generally remain until the indication for insertion has resolved. In some instances however, the tracheostomy will be permanent. A laryngectomy is a permanent surgical change to the airway anatomy. Some of the physiological changes are advantageous to us as clinicians treating these patients. Others necessitate extra vigilance and care.

Upper airway anatomical dead space can be reduced by up to 50%

This can be advantageous when weaning patients from mechanical ventilation. The dead space takes no part in gas exchange and adds to the work of breathing. Reducing this can help patients with critical respiratory reserves get off a ventilator.

The natural warming, humidification and filtering of air that usually takes place in the upper airway is lost

This is one of the biggest dangers with a tracheostomy or laryngectomy. Secretions will become thick and dried and can easily obstruct a stoma or tube. This situation is made worse if there are copious secretions.

The patient's ability to speak is removed

This is a big problem for the patient and can lead to distress and anxiety. Sometimes, we can use aids like speaking valves to help patients vocalise, but attentive and nursing staff are probably the most valuable source of help. Communication boards can be useful too (Figure 3.22).

Figure 3.22 An electronic communication board.

Sense of taste and smell can be lost

This can reduce appetite and general well-being of the patient. Patients report this as a significant problem, which can be easy to overlook when managing their 'medical' problems.

Altered body image

This is an important factor as it can have a major psychological impact. If possible, the patient should have careful preoperative explanation. If this is not possible, the patient must receive explanation and support postoperatively. Inform the patient that scarring will be minimal when the tracheostomy is removed and the stoma has healed and, that speech will return (as long as the vocal cords remain intact). On average, the stoma will close and heal within 4–6 weeks. However, this may vary from patient to patient depending on factors affecting wound healing.

The ability to swallow is adversely affected

Most people with a new tracheostomy will have a nasogastric tube or similar feeding route and regimen established. The cuff of the tracheostomy or the tube itself interferes with the swallowing mechanics of the larynx (Figure 3.23). These muscles can waste if not used (during prolonged ventilation) and require careful rehabilitation and assessment. The Speech and Language Therapist (SALT) is an essential member of the multidisciplinary team.

Figure 3.23 The cuff of the tracheostomy tube can be seen to be impinging on the oesophageal lumen.

Reproduced with permission of HEE eLfH.

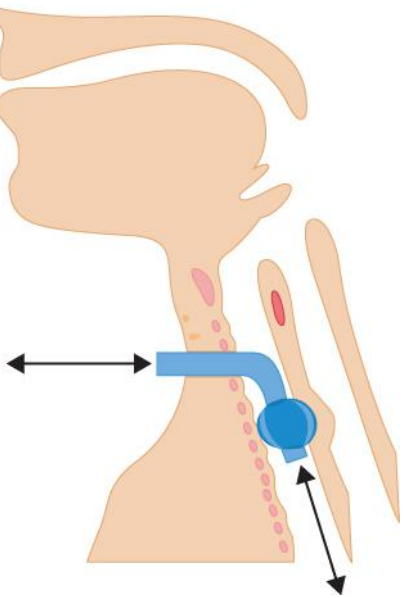


Figure 3.23 depicts an inflated tracheostomy tube. The cuff is pressing on the oesophagus behind the trachea, offering a physical obstruction to swallowing. The tracheostomy tube tethers the anterior structures of the neck and limits the amount of movement of the larynx and upper airways that is required for normal, safe swallowing.

Chapter 4

Different types of tracheostomy tubes

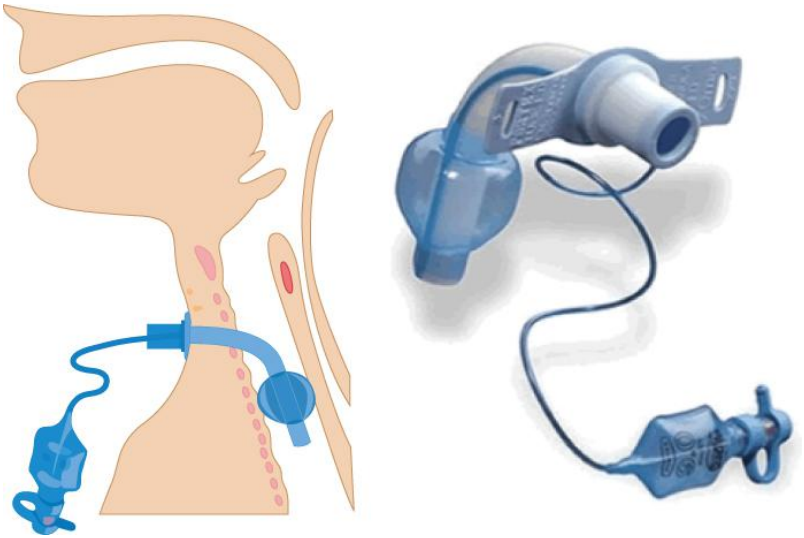
The different types of tubes available can seem confusing. Essentially, tubes can be described by the presence or absence of a cuff at the end, the presence or absence of an inner cannula or the presence or absence of a hole or 'fenestration'. Tubes can be made of different materials and be of different diameters and lengths. Most modern tubes are made from medical grade polyvinyl chloride, polyurethane, silicone or a combination of these materials. Some are lined with special films to reduce the 'biofilm' that may develop inside the lumen. There are illustrations and diagrams of the different functions of the range of tubes available via the e-learning section of the website www.tracheostomy.org.uk. Alternatively, narrated presentations can be found in the url present in the footnote: Explanations of these different types of tubes and cuffs.[1]

Cuffed tubes

Cuffed tubes have a soft balloon around the distal end of the tube which inflates to seal the airway (Figure 4.1). Cuffed tubes are necessary when positive pressure ventilation is required or in situations where airway protection is essential to minimise aspiration of oral or gastric secretions (although all cuffs are not an *absolute* barrier to secretions). If the tracheostomy tube lumen is occluded when the cuff is inflated, the patient will not be able to breathe around the tube, assuming the cuff is correctly positioned and inflated within the trachea.

Figure 4.1 Cuffed tracheostomy tubes.

Reproduced with permission of HEE eLfH.

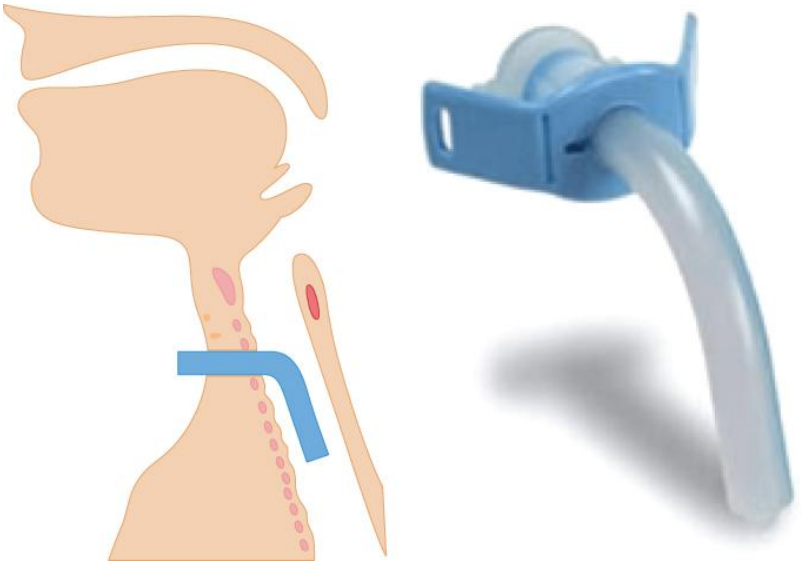


Uncuffed tubes

Uncuffed tubes do not have a cuff that can be inflated inside the trachea and tend to be used in longer term patients who require ongoing suction to clear secretions. These tubes will not allow sustained effective positive pressure ventilation as the gas will escape above the tracheostomy tube. It is essential that patients have an effective cough and gag reflex to protect them from aspiration, as there is no cuff to 'protect' the airway. Uncuffed tubes are rarely used in acute care (Figure 4.2).

Figure 4.2 Uncuffed tracheostomy tubes.

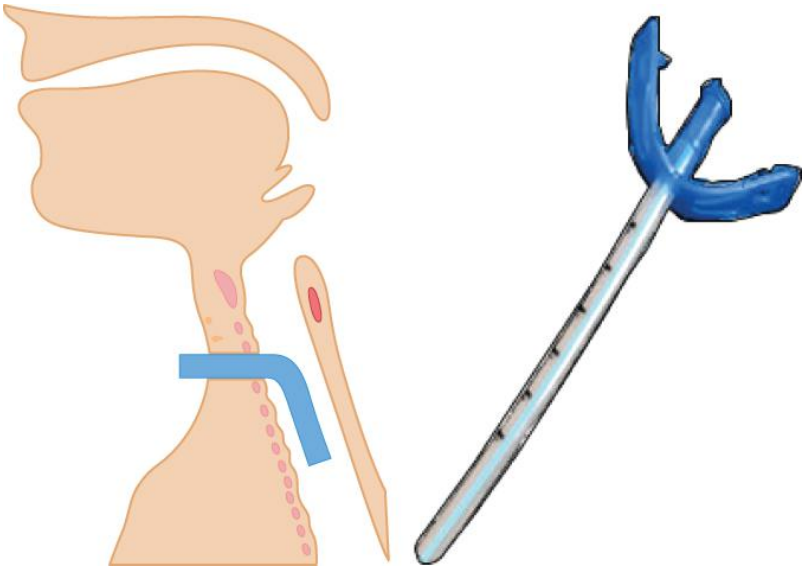
Reproduced with permission of HEE eLfH.



Another type of uncuffed tube is the minitrach tube. These are typically 4 mm internal diameter and have no cuff. They are primarily designed to allow airway toilet (suction) but can facilitate delivery of oxygen. They are too small to provide any ventilation or removal of carbon dioxide and so can only be considered an emergency method of oxygenation. Minitrachs are sometimes used when preparing to decannulate a patient. The minitrach can remain in the stoma and keep it patent in case a tracheostomy tube needs to be reinserted. Minitrachs can also be inserted through the cricothyroid membrane. Specialised insertion kits are available for this, either electively or in an emergency (Figure 4.3).

Figure 4.3 Minitrach tubes.

Reproduced with permission of HEE eLfH.



Fenestrated tubes

Fenestrated tubes have an opening(s) on the outer cannula, which allows air to pass through the patient's oral/nasal pharynx as well as the tracheal opening. The air movement allows the patient to speak and produces a more effective cough. However, the fenestrations increase the risk of oral or gastric contents entering the lungs. It is therefore essential that patients who are at high risk of aspiration or on positive pressure ventilation do not have a fenestrated tube, unless a non-fenestrated inner cannula is used to block off the fenestrations (see Figure 4.4).

Figure 4.4 Fenestrated tubes can be cuffed or uncuffed; the various inner tubes are shown.

Suctioning with a fenestrated tube should only be performed with the non-fenestrated inner cannula *in situ*, to ensure correct guidance of the suction catheter into the trachea.

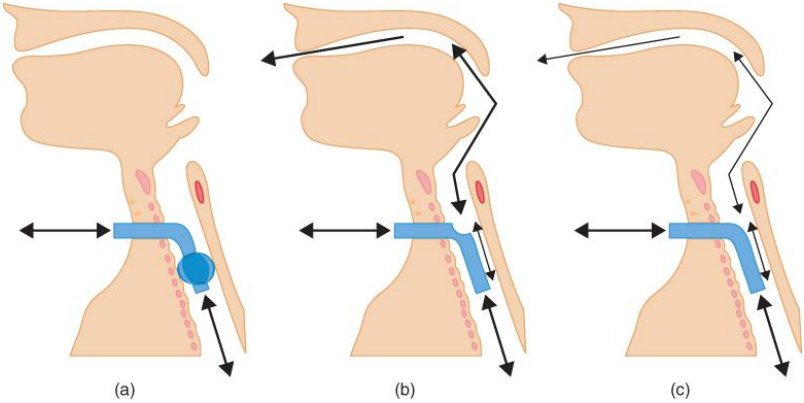
The upper type of inner tube (Figure 4.4) has a fenestration in it, which lines up with the fenestration in the outer tube. Air can then flow through the tube as before, but, in addition, some air can flow through the holes and out through the patient's mouth. This air flow to the upper airway allows the patient to talk. If positive pressure needs to be given to the patient to aid ventilation, for example, in the event of a cardiac arrest or worsening respiratory function, then the tracheostomy inner tube without the fenestrations should be fitted. This then allows positive pressure airflow to enter the lungs rather than escaping through the mouth.

The lower inner tube (right) has no hole (or fenestration) and so air flow is allowed straight through the tube from one open end to the other. When this is *in situ*, minimal amounts of air pass through the patient's upper airway. This inner tube should be in place when the patient is suctioned as there is a small risk of a suction catheter passing through the fenestration and damaging the tracheal mucosa (Figure 4.4).

Figure 4.5 demonstrates different airflow patterns with different tubes inserted. There are video demonstrations available in the url present in the footnote.[2]

Figure 4.5 Different airflow patterns with different tubes inserted.

Reproduced with permission of HEE eLfH.



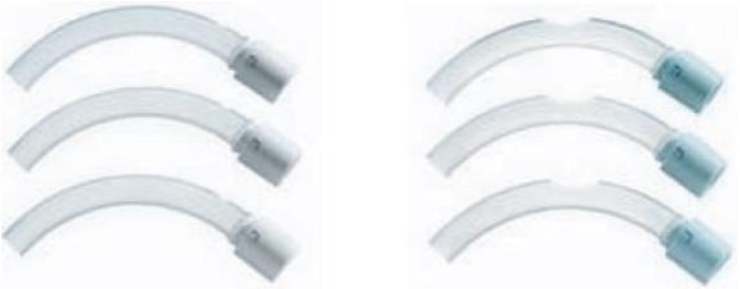
Single-cannula tubes

Single-cannula tubes were historically the first to be sited in a critical care area. The system is less complicated than a double-cannula tube and is usually for temporary use only. These tubes can be cuffed or uncuffed. The larger inner diameter of the single-cannula tube allows lower inflation pressures to be used when the patient is ventilated, as the larger diameter offers lower resistance to gas flow. The Intensive Care Society (ICS) in their 2008 guidance have recommended that these tubes are not used routinely in critical care, owing mainly to concerns about them becoming occluded with secretions and the difficulty in cleaning this type of tube. Indeed, without a removable inner cannula, if these tubes do become blocked, often the only way to unblock them is to change the whole tube. Depending on the nature of the stoma and the condition of the patient, this can clearly be hazardous.

Double-cannula tubes

Double-cannula tubes have an outer cannula to keep the airway open and an inner cannula that acts as a removable liner to facilitate cleaning of impacted secretions. Some inner cannulae are disposable; others must be cleaned and reinserted (Figure 4.6). Patients discharged from a specialist area with a tracheostomy should have a double-lumen, ideally uncuffed, cannula in place. This type of tube is the safest to use outside the specialist environment, although to reduce the incidence of tube occlusion, the inner cannula must be regularly cleaned. If an uncuffed tube becomes blocked, it is more likely that a patient can breathe past the tube via their upper airway, making these tubes inherently safer for non-specialist locations. If there is a high risk of aspiration or need for long-term ventilation, then a cuffed tube may be required long term.

Figure 4.6 Double-cannula tubes.



Regular care of the inner tube will prevent the accumulation of secretions and reduce the risk of tube blockage as shown in Figure 4.7. The inner tube should be removed and cleaned in sterile water every 6–8 h, or more frequently if there is a heavy secretion load. A spare inner tube should be kept in a clean container at the patient's bedside when not in use. It should be noted that some designs of tracheostomy tubes require the inner cannula to be *in situ* before the tracheostomy can be connected to an anaesthetic breathing circuit. It is essential that you understand the equipment being used in your place of work. Videos showing inner tube care can be found here,[3] with YouTube videos from the NTSP here.[4]

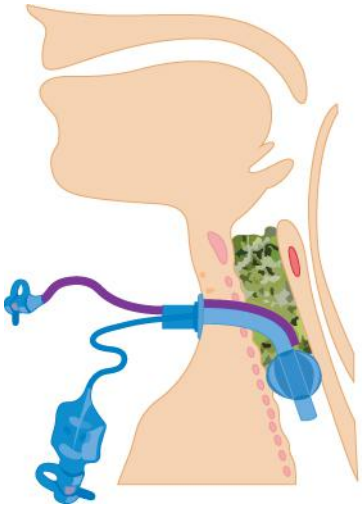
Figure 4.7 Build-up of secretions.

Reproduced with permission of NHS Glasgow & Clyde.

Tubes with sub-glottic suction

As part of a bundle of care, sub-glottic suction may reduce the incidence of ventilator-associated pneumonia occurring in those patients who require mechanical ventilation via a tracheostomy tube. Tubes that allow continuous or intermittent suction of any material that accumulates above the inflated cuff of a tracheostomy tube are now available from various manufacturers (Figure 4.8). Again, when the patient leaves the specialist environment, these tubes should be changed for more simple devices. The extra tubing can potentially confuse carers and there is at least one report of the sub-glottic suction port being connected to enteral feed in error.

Figure 4.8 Sub-glottic suction tubes.



Adjustable flange tracheostomy tubes

These tubes are used in patients who have an abnormally large distance from their skin to their trachea, and a standard tube would not fit properly. There are now dedicated kits for inserting these tubes. Standard tubes may not be the correct size for many critical care patients and increasing numbers may require these tubes. Clinical examination and ultrasound and endoscopic inspection before and after a tracheostomy procedure may help decide which patients require these types of tubes.

Particular indications for an adjustable flanged tube are

- patients with very large neck girth, including the obese;
- oedema caused by burns classically or a capillary leak syndrome (sepsis, etc.);
- actual or anticipated oedema after surgical procedures (including tracheostomy itself).

It is essential to review the position of the flange (hence the length of the tube) on a daily basis. If the patient has neck swelling, as this worsens or resolves, the flange may need adjusting. Adjustable flange tracheostomy tubes are more difficult to use and are associated with additional complications, some of which may be life-threatening. As the population becomes increasingly obese, we expect around 30% of patients requiring a tracheostomy may need these larger tubes. Newer adjustable flange tracheostomy tubes can have an inner tube.

Choice of tracheostomy tube

The UK ICS produced guidance on tracheostomy care in 2008, which included information on the choice of tracheostomy tube. This is summarised later with expansion in some sections.

An important consideration is whether to use a tracheostomy with an inner tube from the time of initial percutaneous tracheostomy, which may be performed for weaning on the Intensive Care Unit (ICU). It is increasingly recognised that tube obstruction can occur in critical care areas, as well as on the wards and the ICS recommend that these easily cleanable tubes should be used where possible as standard to reduce the risks of obstruction. The disadvantage is that these tubes have a reduced internal diameter, which has implications for gas flow. There is also the problem of repeated disconnection from a ventilator, which can cause de-recruitment of the lung with disadvantages for gas exchange in the critically ill. Once the patient can tolerate ventilator-free periods (typically around 50% inspired oxygen as a guide) inner tubes may be used. These factors have to be balanced against the increased risks of tracheostomy tube obstruction with single-lumen tubes, and the possibility of requiring a tube change if the patient is to be moved to a non-critical care area. A tracheostomy tube should not be changed for 7–10 days if possible after a percutaneous procedure.

Factors influencing temporary tracheostomy tube choice

Respiratory function

Most temporary tracheostomies inserted to assist with ventilation will be inserted while a patient is in an intensive care unit and still requiring some degree of positive pressure ventilation. This will require the use of a cuffed tracheostomy tube (although it is recognised that long-term mechanical ventilation can be delivered through an uncuffed tube in certain circumstances).

Abnormal airway anatomy

Upper airway endoscopy following percutaneous insertion suggests that a standard tracheostomy tube may be anatomically unsuitable in as many as one-third of adult patients. Obese patients may require a tube with an extended proximal length, while patients with fixed flexion abnormalities may not easily accommodate tubes with a fixed angulation. Localised airway pathology, such as tracheomalacia, granuloma formation, and so on may on occasion necessitate the use of a tracheostomy tube that has a longer distal length than standard.

Compromised airway, protection and weaning problems

Patients can be weaned to decannulation without any need to change from the cuffed tracheostomy tube that was initially inserted. In some cases, however, it may be useful to consider options such as downsizing to an uncuffed or fenestrated tube, or a tube with the option for sub-glottic

aspiration of airway secretions. The introduction of a speaking valve may also aid swallowing and secretion control (see next section).

Speaking

Consideration of whether the patient is able to speak, whether it is desirable for them to speak (laryngeal training) or indeed if they want to attempt speech can dictate the type of tube inserted. If the patient has significant 'mouth breathing', then they may benefit from a smaller tube to allow more air to pass around the tube. If a larger tracheostomy tube is required or desired (e.g. the patient requires intermittent cuff inflation and mechanical ventilation), then a fenestrated tube may be a better choice.

Obstructed/absent upper airway

Patients with an obstructed or absent upper airway are at particular risk should a tracheostomy become obstructed or misplaced. This has implications for both the choice of tracheostomy tube as well as the method by which the stoma is fashioned.

Clinical environment

Obstruction of a cuffed tracheostomy tube is a potentially life-threatening emergency. Wherever possible, a dual-cannula tube (i.e. a tube with an inner cannula) should be used, particularly for patients cared for outside of a specialist environment who may not have immediate access to clinicians with emergency airway skills. Ward staff can change inner tubes easily and quickly to relieve obstruction with secretions.

The location that patients will be managed in will also influence the choice of tube. Simpler tubes without additional sub-glottic suction ports and channels will reduce the potential for confusion. If the patient is going to be discharged to a facility outside of a hospital environment, then consideration should be made to how easily the carers can manage with the device that is inserted. This will include balancing the risks of using a cuffed tube.

Tubes from different manufacturers

There are many different manufacturers of tracheostomy tubes and devices around the world, some tubes with significantly different internal and external diameters and others with significantly different lengths and angulations. Table 4.1 and Figure 4.9 demonstrate some key measurements from a selection of tubes widely available in the UK (ID/OD—internal/outer diameter, lengths in millimeters). It can be seen that even with the same 'size' tubes, there can be significant differences in the diameter of the internal tube (Figure 4.10).

Table 4.1 Varying tube dimensions from different manufacturers.

Manufacturer/tube	ID without inner	ID with inner	OD	Length
Shiley DCT	n/a	7.6	12.2	79
Kapitex Tracheotwist	n/a	8.0	11.4	76
Portex Blue Line Ultra	8.0	6.5	11.9	75.5

Figure 4.9 Adjustable flange tracheostomy tubes.

Figure 4.10 Tube dimensions may vary across different manufacturers.

A comprehensive list of the various sizes of many of the world's tracheostomy and laryngectomy tubes can be found in Linda Morris' book, *Tracheostomies—The Complete Guide* (Chapter 4) Springer, 2010.

[1] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Basics.htm

[2] http://www.youtube.com/watch?v=_TGwkxbhGcU

[3] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Inner Tubes.htm

[4] http://www.youtube.com/watch?v=VPYiksEt-qA

Chapter 5

Management of the day-to-day needs of the patient with a tracheostomy and laryngectomy

This section covers some of the daily considerations for neck-breathing patients, their carers and medical and nursing teams. The topics covered in this section are given below.

- Daily checks
- Humidification
- Suctioning
- Stoma care and securing the tube
- Management of the inner cannulae
- Oral care and swallowing
- Cuff management
- Tube changes
- Weaning, downsizing, caps and speaking valves and planning for decannulation
- Decannulation
- Bedside equipment
- Laryngectomy humidification
- Speech after laryngectomy
- Patient information sheets.

Daily checks

There should be a detailed plan of care for all patients with a tracheostomy. A suggested care plan is provided in this manual, but local policies may already be in place. The care plan should be reviewed on a daily basis and updated if there is any change.

The patient with a tracheostomy needs diligent observation and assessment. The nurse caring for the patient is responsible for this, seeking advice from other professionals as appropriate.

Patient assessment

At the start of each shift, the staff nurse caring for the patient with a tracheostomy should carry out a full assessment of the patient, which should include:

- why did the patient have a tracheostomy?
- when was the tracheostomy performed?
- was it surgical or percutaneous (may have implications for ease of reinsertion) and does the patient have a larynx? (i.e. does the patient have a communication between the oral airway and the lungs?); bedhead signs at the patients' bed space to quickly and easily communicate this information
- type and size of tracheostomy tube and availability of spare and emergency equipment
- cough effort
- ability to swallow, including any SALT assessments
- sputum characteristics (colour, volume, consistency, odour)
- check and change inner cannula for any build-up of secretions (see later)
- check tracheostomy holder is secure and clean
- check stoma dressing is clean
- routine observations.

This assessment should be documented on the care plan at the start of every shift.

Humidification

It is mandatory that a method of artificial humidification is utilised when a tracheostomy tube is *in situ*, for people requiring oxygen therapy—'dry' oxygen should never be given to someone with a tracheostomy or laryngectomy. The type of humidification will be dictated by the needs of the patient.

During normal breathing, inspired air is warmed, filtered and moistened by ciliated epithelial cells in the nose and upper airways. However, these humidifying functions are bypassed by a tracheostomy tube or

laryngectomy and air inspired will be cold and dry. Inadequate humidification can result in a number of physiological changes that can be serious to the patient and potentially fatal, including:

- retention of viscous, tenacious secretions
- impaired mucociliary transport
- inflammatory changes and necrosis of epithelium
- impaired cilia activity
- destruction of cellular surface of airway causing inflammation, ulceration and bleeding
- reduction in lung function (e.g. atelectasis/pneumonia)
- increased risk of bacterial infiltration.

As a result, humidification must be artificially supplemented to assist normal function and facilitate secretion removal. **Failure to adequately humidify could result in tube or stoma blockage as secretions become dry and viscous, forming a crust around the tracheostomy**.

The assessment of a patient with a tracheostomy should include management of their secretions and should identify the effectiveness and adequacy of the current humidification of that patient. Maintaining systemic hydration is also important and a dehydrated patient is at a greater risk of developing problems because of thick and dry secretions.

A tracheostomy tube can become completely blocked by thick secretions, leading to a respiratory arrest. This can be prevented by regular and effective assessment of the patient's humidification, regular inner cannula care and suctioning. Warning signs, which will allow for an appropriate change in management, can be identified; and this should prevent tube blockage.

Patient assessment should include:

- frequency of suctioning and/or cleaning or inner cannula
- tenacity of secretions
- evidence of airflow via tracheostomy
- respiration rate
- use of accessory muscles
- patient coughing (ineffective or excessive)
- requirement for supplementary oxygen.

High-risk patients include those with reduced or thickened secretions and those with a longer length and/or single-lumen tube. These patients should be cared for with extra vigilance in order to minimise the risk of tube blockage.

Methods of artificial humidification

The chosen method of humidification will:

- provide adequate humidification of chest secretions
- help maintain body temperature
- be convenient and cost-effective
- be physically suited to the patient.

Consideration should be made relating to the potential infection risk of each device. Any chosen device should be used in accordance with the manufacturer's guidelines and staff trained and assessed as competent in its use.

Heated humidification

Heated humidification operates actively by increasing the heat and water vapour content of inspired gas. Gas can be delivered fully saturated at core temperature, depending on the system employed. A heater and water bath system is shown in Figure 5.1. These systems are indicated for tracheostomy patients requiring mechanical ventilation or oxygen therapy for ≥ 96 h. This type of humidification is more effective than heat moisture exchanger (HME) filters for those patients receiving artificial ventilation and should be used if the HME is not adequate.

Figure 5.1 A heater and water bath humidification system.

Cold humidification

Cold humidification bubbles gas through cold water, but only delivers a relative humidity of around 50% at ambient temperatures. For tracheostomy patients on high inspiratory flow rates of oxygen with tenacious secretions or patients complaining of subjective dryness, a heated device is indicated.Note: Condensation from heated or cold humidification should be considered infectious waste and disposed of according to hospital policy using strict universal precautions. Because condensate is infectious waste, it should never be drained back into the humidifier reservoir.

Saline nebulisation

The nebuliser unit converts saline into a supersaturated aerosol of liquid droplets which penetrate the lung, moistening the airways. It may be indicated in tracheostomy patients who are mechanically ventilated, receiving oxygen therapy or self-ventilating on air (Figure 5.2).

Figure 5.2 Saline nebulisation.

Saline nebulisers help to reduce the viscosity of secretions, which makes them easier to remove by suction or cough. Saline nebulisation involves administration of 5–10 ml 0.9% sterile normal saline into the nebuliser unit 2–4 hourly or as required. Nebulisers must be connected to a gas source with a flow rate of 6–8 l/min (or follow manufacturer's guidelines). Remember that if the patient requires supplemental oxygen, then the gas driving the nebuliser should be oxygen and not air. Ensure that nebulisation is given via the tracheostomy (not the face mask!). A nebuliser can be attached to a tracheostomy mask or a T-piece circuit.

Heat moisture exchanger (HME)

HMEs consist of rolls of metal gauze or a condenser element like propylene sponge/fibre sheet/corrugated paper. These products are placed either directly onto the end of the tracheostomy tube or can be placed into a breathing circuit. They conserve heat and moisture on expiration via the tube. They need to be checked regularly to ensure they are not occluded by secretions, which may obstruct the airway. They require checking regularly and must be changed at least every 24 h. Some product ranges also offer oxygen delivery inlets, suction ports. Heat moisture devices are available as small cylinders or nozzles that attach directly to tracheostomy tubes, allowing for patient mobility and may have speaking valves incorporated in them (Figure 5.3).

Figure 5.3 Different types of HME: (a) thermovent, (b) for anaesthetic circuits and (c) 'Swedish nose'.

(a) (b) (c)

Stoma filters or bibs

This group of humidification devices contains a foam layer that absorbs moisture from the patient's expired gases. They are predominantly used for established tracheostomy patients and are often favoured by patients as they are less bulky and conspicuous and are able to completely obscure the tube from sight.

Figure 5.4 shows a 'Buchanan bib'. These can be used by tracheostomy or laryngectomy patients and come in a variety of styles and designs. Some can disguise the stoma completely and the patient just appears to be wearing a scarf or cravat (see Figure 5.5).

Figure 5.4 A Buchanan bib.

Figure 5.5 Patients wearing stoma filters.

Mucolytics

This group of medications reduce the 'thickness' of secretions by breaking down some of the bonds that exist between the mucus. They are indicated when the patient has excessively thick secretions that are difficult to

expectorate. Examples include hypertonic saline or acetylcysteine (via nebuliser), carbocysteine (via mouth) or DNAases such as dornase alfa (used in conditions such as cyctic fibrosis).

Hydration

Ensuring that the patient is adequately hydrated is essential in managing the secretion load of a patient. This can be enteral, intravenous or even subcutaneous.

Documentation

Given here is a list of practices that should be recorded.

- The method of humidification in use in the patient's care plan or clinical record as per local procedure
- Evidence of evaluation and instigation of action taken in the patient's care plan or clinical record as per local procedure
- A signature for accountability of care for each shift as per local procedure
- The date and time that devices are changed and/or are due to be changed.

Humidification ladder

The level of humidification required by patients will change depending on their clinical state, level of respiratory support required and their degree of hydration. If the current degree of humidification is not adequate enough, then the patient should be ‘stepped up’ to the next level. Patients with tracheostomies and laryngectomies are incredibly vulnerable to complications as a result of inadequate humidification, and the importance of preventing tracheostomy-related complications cannot be emphasised enough. This becomes even more important if the patient is unwell, dehydrated or has purulent secretions.

The humidification ladder

Heated water bath (active humidification)

- Ventilated patient with thick secretions
- Self-ventilating patient (on oxygen) with thick secretions

HME for breathing circuit

- Ventilated patient with minimal secretions (replace every 24 h)
- Monitor effectiveness (less likely to be effective if required for more than 5 days)

Cold water bath

- Self-ventilating patient (on oxygen)

HME (Buchanan bib, Swedish nose)

- Self-ventilating patients (no oxygen).

Add saline nebulisers or mucolytics and ensure adequate hydration if secretions aren't improving.

Other methods of improving secretions

Mobilisation

There is good evidence, borne out by expert opinion and commentary, that mobilising patients will help improve the clearance of secretions. Mobilisation should be encouraged for all patients with an airway stoma. The assistance of physiotherapists is essential for patients who cannot mobilise independently, or who are sedated and/or ventilated. These interventions can be combined with aggressive chest physiotherapy.

There is evidence that patient movements and interventions can be associated with an increased risk of tracheostomy tube displacement, but others have clearly shown that careful mobilisation of even the most dependant patients can be achieved safely, without increasing the risks of

tube displacement, while reducing the risks of pneumonia and shortening time receiving invasive ventilation.

Instilled saline

This practice is advocated by some when secretions prove difficult to manage. There is no clear evidence for benefit or harm. Saline is probably most effective when directed using a bronchoalveolar lavage, which is appropriate for discrete areas of mucus plugging, especially if associated with distal collapse or consolidation. Bronchoscopy may require sedation, but is technically straightforward via a tracheostomy in experienced hands.

Suctioning

Suctioning the airway is an essential part of routine care of the tracheostomy and laryngectomy patient. Sputum is continually produced when healthy and our native airways deal with this load without any difficulty. If there is an infection or the sputum load increases, there is an increased risk of the secretions causing problems such as airway obstruction or consolidation in the lung. These problems are compounded if the patient cannot cough effectively, the inhaled gases are not adequately humidified, the patient is on a ventilator or the presence of a tracheostomy or laryngectomy compromises the body's ability to deal with the secretions.

The health of the lower respiratory tract is usually maintained by its mucus blanket. Mucus produced in the trachea and bronchi is transported up to the larynx by the ciliated mucosa of the trachea. The mucus blanket is disturbed following tracheostomy for the following reasons:

- the loss of normal humidification from the nasal airway;
- the post-surgical inflammation produces a more tenacious mucus blanket;
- the presence of the tracheostomy tube paralyses the cilia in contact with it;
- the loss of a normal cough from bypassing the larynx.

This results in the tracheal mucus collecting at the lower end of the tracheostomy tube. The amount of mucus build-up and the problems it causes will vary between patients and with the duration of the tracheostomy. Some patients may be able to project the mucus through the tube by forced expirations, but most often it must be removed by suctioning the trachea via the tracheostomy tube. Suctioning is not a benign process and may cause hypoxia, cardiac arrhythmias, trauma, atelectasis and infection.

Types of tracheal suctioning

Most patients only need routine tracheostomy suction and this should be limited to the lumen of the tube. If the suction catheter is passed deeper into the normal trachea, it can further paralyse the cilia and aggravate the problem. In some patients with chest problems, the tracheostomy will have been performed to give access to the lower respiratory tract. In such patients, deep bronchial suction may be required. Frequency of routine tracheostomy suction varies considerably between patients depending on their clinical status.

Suctioning systems can be ‘open’ or ‘closed’. Open suction involves using single-use catheters inserted via the open end of the tracheostomy tube. Closed suction systems allow the same catheter to be used multiple times. They are especially useful if the patient is connected to a breathing circuit of a ventilator, as repeated disconnection of the circuit is not required. Closed systems are cleaned following use with sterile saline and the systems are usually changed every 72 h, or according to the manufacturer's instructions. They do add a degree of weight to the breathing circuit and the constantly attached suction tubing risks getting caught accidentally, which may increase the risk of inadvertent disconnection or tube displacement.

Figure 5.6 shows a selection of ‘open’ suction catheters and a ‘closed’ suction system, as described earlier. Note the inverted red saline ampule.

Figure 5.6 Suction: (a) ‘open’ catheters and (b) a ‘closed’ system.

(a)

(b)

Patient assessment

In order for the practitioner to assess whether the patient requires suctioning, with an awake, cooperative patient, it may be possible to first encourage them to cough up the secretions, thereby reducing excessive suctioning. Support the patient in a position that will aid coughing (unless contraindicated) and address any factors that may reduce the effectiveness of coughing, such as pain or hydration status.

Indications that the patient may require suctioning include:

- noisy and or moist respirations
- increased respiratory effort
- prolonged expiratory breath sounds
- restlessness
- reduced oxygen saturation levels
- increased or ineffective coughing
- increased use of intercostal muscles
- patient request
- more sinister signs of airway obstruction such as hypoxia and cardiovascular changes.

Sedated or ventilated patients may have deep secretions, which may not lead to some of the signs described. These secretions may need to be mobilised by physiotherapy and attention to humidification before suctioning becomes effective.

Suction catheter selection

Tracheal damage and hypoxia may be caused during tracheal suction. This can be minimised by using the appropriate sized suction catheter. If the catheter is too large, the suction it creates can cause damage. A large catheter will also occlude the tracheal tube, which may cause hypoxia. It has been recommended that the diameter of the catheter should be no more than half the internal diameter of the tracheal tube. If the catheter is too small, it will not be adequate to remove secretions, so repeated attempts will be necessary. This has also been shown to damage the trachea. A rough guide to choosing the correct size of catheter was proposed by Odell and others (1993):

Table 5.1 illustrates this.

Table 5.1 Suction catheter sizing.

Inner diameter of tracheostomy tube (mm)	**Suction catheter size [French Gauge (FG) or mm]**	
	FG	(mm)
10	14	(4.5)
9	12	(4)
8	12	(4)
7	12[a]	(4)
6	10	(3.3)
5	8	(2.6)

[a] It is more appropriate to use a size 12 catheter because, although slightly larger than ½ diameter, it is more effective for secretion removal.

The frequency of suctioning

There is no clear consensus on how frequently a patient should receive suctioning. This will be dictated by the various patient factors related to the ability to spontaneously clear the secretions. Attempting tracheal suction at least once per 8 h strikes a reasonable practical balance. This should ensure that the tube remains patent. Failure to pass a suction catheter is a 'Red Flag' warning that that tube may be blocked or displaced and should prompt assessment by an appropriately trained individual.

The depth of suctioning

Passing a suction catheter to the tip of the tracheostomy tube can be considered 'shallow' suctioning. This is often all that is required if the patient has reasonably loose secretions which can be coughed towards the end of the tube. Passing a suction catheter any further than this can be considered as 'deep' suctioning and may be required if more shallow suctioning does not clear the secretions adequately. Many authors advocate advancing the suction catheter through the tube until it reaches the carina (where resistance will be encountered). The catheter should then be withdrawn slightly before suction is commenced. Clearly, the length of the tracheostomy tube *in situ* needs to be known so that the suction catheter is inserted to an appropriate distance. There is no clear message from the literature to guide suction technique, despite a Cochrane review.

The pressures for suctioning

Choosing the correct pressure is a balance of effectiveness of clearing secretions against limiting the potential for damage, either by directly traumatising the tissues or by aspirating oxygen from the trachea and contributing to hypoxia. Pressures used effectively in the literature range from as little as −80 mmHg to −300 mmHg. Most would agree that a pressure of no greater than −150 mmHg (−20 kPa) is appropriate for most patients.

Equipment for suctioning

- 'Clean' disposable gloves as per local policy
- Protective eyewear
- Appropriately sized sterile suction catheters (see selection guide earlier)
- Sodium chloride 0.9% ampoules (only for closed circuit units)
- Oxygen therapy—wall flow meter and tracheostomy mask—if necessary
- Oxygen saturation monitor—where appropriate
- Suction equipment (wall or portable unit)
- Disposable, sterile 'double' gloves can be used to keep the catheter tip sterile from the packet and allow easy disposal

Most closed suction systems allow the suction tubing from the wall-mounted suction unit to be constantly connected to the catheter assembly. To prevent continuous suction being applied, there is a valve to stop the suction being applied [white lock between the green sections in Figure 5.7(a)]. The tip of the catheter should always be in the withdrawn position when not being used, as shown [the visible black marker, as shown in Figure 5.7(b), indicates that the tube is withdrawn].

Figure 5.7 Closed suction systems showing (a) the valve to stop suction and (b) the black marker indicating the tube is withdrawn. (c) Open suction.

Summary

Table 5.2 summarises the key actions related to suctioning and their rationale (adapted from the NPSA expert working group).

Table 5.2 Suction—key actions to be taken and their rationale.

Action	Rationale
Explain the procedure to the patient	Relieve patient anxieties
Consider analgesia prior to or following suctioning	Suctioning can be a painful procedure
Switch suction unit on and check that the suction pressure on circuit occlusion does not exceed −150 mm Hg or 20 kPa pressure	To ensure the machine is working correctly; too great a suction pressure can cause trauma, hypoxaemia and atelectasis
Wash hands, put on gloves, apron and goggles	Reduce the risk of cross-infection
Ensure that an appropriate non-fenestrated inner tube is in place	Larger fenestrations allow the suction catheter to pass through, causing trauma to tracheal wall or giving the false impression that the catheter will not pass
Consider pre-oxygenation if receiving oxygen or ventilated	To prevent hypoxaemia
Remove tracheostomy devices prior to open suctioning	To allow access for sterile suction catheter tip
Connect suction catheter keeping catheter tip covered (sterile)	To reduce the risk of transferring infection from the hands to the suction tubing
Place top ‘double’ glove on dominant hand	To aid removal and replacement of fresh gloves per each suction episode
Do not apply suction while introducing the catheter, or push against resistance at any time	Suctioning while introducing the catheter causes mucosal irritation, damage and hypoxia
Occlude suction port with gloved thumb and suction on removal of suction catheter (no need to rotate on removal as catheters have circumferential holes)	Prolonged suctioning can result in hypoxia and trauma
Period of suction should not exceed 10 s	To reduce risk of mucosal damage and hypoxaemia
Suctioning should be continuous not intermittent	Intermittent suctioning does not reduce trauma and is less effective

Observe the patient throughout the procedure to ensure their general condition is not affected	Tracheal suction may cause vagal stimulation leading to bradycardia, hypoxia and may stimulate bronchospasm
For patients requiring oxygen therapy, reattach O_2 within 10 s	To limit hypoxia
Remove the glove from the dominant hand by inverting it over the used catheter and dispose clinical waste bag	To minimise the risk of infection
Assess the patients' respiratory rate, skin colour and/or oxygen saturation to ensure they have not been compromised by the procedure and determine if they need further suction	Suction should be performed only when needed and not as part of a routine, so that damage to the trachea is avoided
It is recommended that no more than three episodes of suctioning are carried out in succession	To limit side effects and maximise recovery period
Difficulties in suctioning tenacious mucus may be because of inadequate humidification. Try a more effective	
humidifier. Consider use of nebuliser, mucolytics and concurrent physiotherapy. Saline instillation may be	
useful in some situations, such as deep bronchial suction and bronchial lavage	
If O_2 delivery was increased, review for return to previous level	To prevent unnecessary oxygen delivery
Flush through the connection tubing with the clean water. Empty water receptacle and ensure this is ready for further use Wash hands	To minimise the risk of infection
If the patient needs further suction, repeat the above-mentioned actions using new glove and a new catheter	

Videos demonstrating open and closed suction techniques can be found in the links given in the footnotes and as part of the e-learning modules available at www.tracheostomy.org.uk.

- Open suction[1]
- Closed suction[2]

- Assessment of patency of a laryngectomy stoma[3]

Stoma care and securing the tube

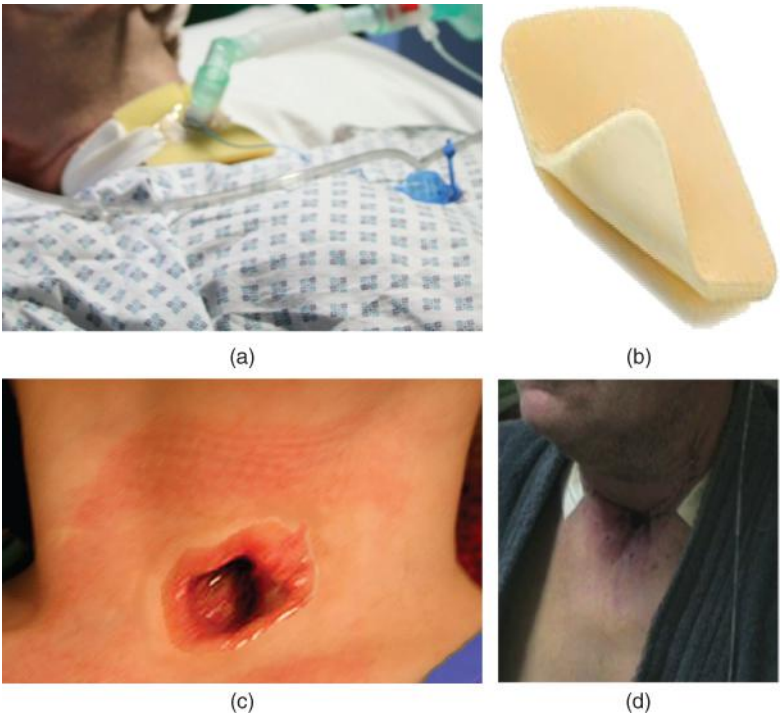
The management of a tracheostomy stoma depends to some degree on the type of surgical procedure used to create the tracheostomy tract. Traditionally, tracheostomy was created through a linear incision in the front of the neck and commonly leads to a larger surface wound compared with percutaneous procedures. The stoma associated with a tracheostomy or laryngectomy can be considered as a full-thickness, open wound, but one that is complicated by the moisture and mucus associated with respiratory secretions. When we add a large foreign body that slides about every time the patient moves, the potential for stoma problems is evident.

Secretions may ooze out of the surgical excision and stoma site, which can result in wetness and cause irritation of the skin and can lead to skin maceration and/or excoriation. This moist environment may also act as a medium for bacterial growth and can prevent the stoma site from healing. The aim of stoma care is therefore to keep the area clean and dry, reducing the risk of skin irritation and infection.

Various types of dressing are available for the stoma. Dressings placed at the tracheostomy site should always be pre-cut by the manufacturers to avoid loose fibres from a cut dressing edge entering into the airway. Thicker dressings will absorb more secretions (e.g. Lyofoam™, Allevyn™) than some of the thinner, less obtrusive varieties available (e.g. Metalline™).

Strict management of these dressings is essential, as wound degradation will occur if wet or soggy dressings remain in contact with the surrounding skin. The tracheostomy wound should be inspected at least daily. Any pus should be swabbed and sent for microbiological culture. Excessive moisture or secretions may be because of an underlying respiratory infection, which should be treated appropriately (Figure 5.8).

Figure 5.8 Tracheostomy dressings.



Inspection of the stoma should also include assessment of where the tapes or ties are in contact with the skin of the neck or face, including the back of the head. Sometimes, the patient's head position means that the tube will cause pressure areas on the skin of the neck (Figure 5.9) or chest. Specialist advice and consideration of a different tube type may be required.

Figure 5.9 Pressure wound resulting from tube fixation.

Securing the tube in position

Tracheostomy tubes can be secured with cloth or cotton ties, or Velcro holders. A balance must be struck between securing the tube in position and minimising any risks of causing pressure ulceration (see Figure 5.10; with permission). One finger should be able to be inserted between the tape and the patient's skin to ensure the tube is adequately secured. Tube displacement is more common in the first few days following tracheostomy insertion. Consequently, many centres will suture the tube to the neck skin in addition to the tracheostomy tapes for the first 7–10 days until the tract becomes well established. This may make removing the tube in an emergency more difficult should it become partially displaced and is not mandatory. Suturing also may make cleaning under the tube more difficult. The bedhead sign should make clear what sutures are *in situ* and how long they should remain for. The sutures pictured here are inflamed and should be removed if the stoma has matured.

Figure 5.10 Tracheostomy tube *in situ* with inflamed sutures visible (with permission).

Patient assessment

When selecting the most appropriate technique and product for securing the tracheostomy tube, consideration must be given to the risk factors that each patient is exposed to. A tracheostomy tube that becomes displaced is at risk of causing significant respiratory difficulties and/or airway obstruction. It is, therefore, vital to ensure the tracheostomy tube is appropriately secured at all times. Patients at risk of their tube becoming displaced are:

- those who are agitated or confused
- those with ventilator circuits attached
- those with tapes that are too loose allowing excessive tube movement.

Regular checks of the tapes will help prevent the tube becoming displaced. The patient who has undergone reconstructive surgery to the neck area, which may include a skin and/or muscle flap, may well require the tracheostomy tube to be secured without applying pressure to the delicate flap area. For such a patient, the tube is likely to be secured to the area directly surrounding the tracheostomy, by sutures. Care must be taken to ensure these sutures adequately support the tube in place and prevent tube misplacement.

Equipment in addition to standard bedside equipment

- Dressing trolley
- Gloves, disposable apron and protective eye wear
- Sterile dressing pack
- A 0.9% sterile saline solution (warmed ideally)
- Sterile gauze squares
- Tracheostomy dressing (pre-cut)
- Tracheostomy securing device: either Velcro tube holder or cotton ties (two pieces approximately 50–80 cm each)
- Blunt-ended scissors
- Barrier cream
- Suction unit with appropriate suction catheters.

Procedure

Two people should be present when changing the tapes to help prevent accidental decannulation. It should be clearly communicated throughout the procedure as to which person is responsible for holding the tracheostomy tube. The procedure must be undertaken using an aseptic technique to prevent contamination and risk of infection. Videos of dressing and tube tie changes can be found here, along with the e-learning sessions at www.tracheostomy.org.uk.

- Video of dressing and tube tie change[4]
- Dressings and ties captivate presentation here[5]

Documentation

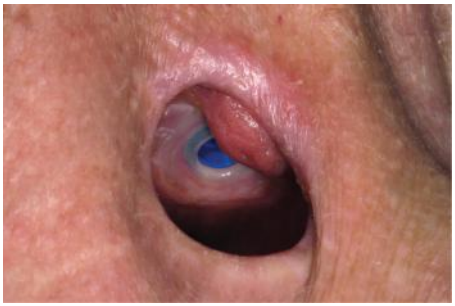
Any dressing or tape change should be documented in the nursing and/or medical notes as appropriate. Any complication identified (e.g. infection and swabs taken) should be considered for further management and this also documented.

Granulation tissue

Overgranulation or hypergranulation at the site of the tracheostomy can be caused by an ill-fitting tube, excessive movement of the tube and/or in response to an infection at the wound site. This tissue can cause bleeding or pain at the wound site and in severe cases make tracheostomy tube changes difficult.

A polyurethane dressing significantly reduces the rate of hypergranulation. Treatment may include local application of silver nitrate. This requires local skin to be protected with petroleum jelly, and may require repeat applications until the overgranulation tissue has shrunken sufficiently. Figure 5.11 shows granulation tissue visible around a tracheo-oesophageal puncture (TEP) valve, which is visible via the laryngectomy stoma.

Figure 5.11 Granulation tissue around a TEP valve.



Patients undergoing radiotherapy to the neck

Carrying out a tracheostomy dressing and tape change for a patient undergoing radiotherapy to the neck must be carried out with caution and particular consideration to the increased discomfort the patient may experience.

Radiotherapy may cause radiotherapy burns, moist or dry desquamation and broken areas of skin. It is advisable to liaise with the radiotherapists to

assess skin integrity and to advise on suitable skin treatments. Appropriate analgesia may also be required prior to tapes and dressing changes. It is also the practitioner's responsibility to identify appropriate timing of tapes and dressing changes and not to be considered simply routine care to avoid unnecessary discomfort or skin damage.

Summary

Table 5.3 summarises key actions related to stoma care and their rationale (adapted from the NPSA expert working group).

Table 5.3 Stoma care—key actions to be taken and their rationale.

Action	**Rationale**
Explain and discuss the procedure with the patient as appropriate	Reduce anxiety and gain consent and cooperation
Wash hands and put on gloves, apron and eye protection if patient is high risk	
Prepare sterile dressing trolley	Prerequisite for maintaining asepsis
Position the patient with the neck slightly extended and remove any clothing that will impede procedure	To help access to the neck area for the procedure
Practitioner 1 holds the tracheostomy tube, while practitioner 2 removes the tapes and dressing	To stabilise the tracheostomy tube and reduce the risk of dislodgement of tracheostomy tube
Discard old tapes and dressings into the waste bag	
Assess the stoma for signs of infection, inflammation, or trauma, and record accurately on the appropriate documentation Take a swab if there are any signs of infection—these include: • purulent discharge • pain • odour • abscess formation	To assess for skin excoriation, haematoma, signs of infection To facilitate early recognition and treatment of infection

• cellulitis and discolouration	
Observe for signs of hypergranulation	Granulomas may cause scarring, bleeding, pain and cause difficulty at tube changes
Perform hand hygiene and change gloves to proceed with aseptic wound care and dressing application	To adhere to aseptic technique
Sterile gauze squares soaked in saline should be used to clean the wound and around the tube to remove secretions and crusting; gently pat dry	Saline is the preferred wound cleansing solution
The tube should be held firmly throughout with minimal movement of the tube	Tube movement can cause coughing and discomfort and may increase the risk of accidental decannulation
Apply a thin layer of barrier cream if the skin is at risk of excoriation from moisture from humidification and/or secretions	To promote skin integrity
Apply a clean tracheostomy dressing	To bring secretions away from the wound, and also to provide comfort from the tube constantly resting on the neck
Re-secure the tube using an appropriate tie; allow one finger's distance between the tie and the neck skin	Secure the tube effectively

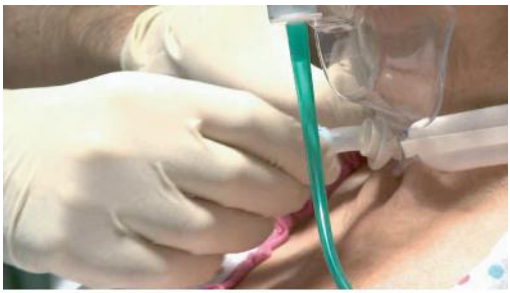
Management of the inner cannulae

Most tubes are available with removable, and therefore cleanable, inner cannulae. Designs and materials are improving all of the time and a tube with an inner cannula does not necessarily mean that the internal diameter (and subsequent resistance to air flow) is as compromised as it perhaps used to be with previous designs. Cleaning aims to remove secretions

from the inner cannula to reduce the risk of potential obstruction with sputum and subsequent infection. Secretions can adhere to the internal lumen of a tracheostomy tube and severely reduce the inner lumen diameter over time. This potentially can increase the work of breathing and/or obstruct the patient's airway.

The inner cannula should be removed and inspected at least once per 8-h shift or if the patient shows any signs of respiratory distress. For a patient undergoing mechanical ventilation, it may not be safe to repeatedly disconnect the ventilator circuit and change the inner tube routinely. Cleaning or changing an inner tube should always represent the best balance of risks to the patient. If an inner tube is not changed, then it should be clearly documented and communicated, along with the rationale.

Figure 5. EXTRA-1 (a) Inner tubes can be removed and cleaned and may have holes (fenestrations) in them. (b) Different manufacturers' designs may require the inner tube to be in place to connect to a standard anaesthetic or ventilator circuit.



(a)

(b)

There is debate within the literature on the most appropriate cleaning solution to be used in the context of inner cannula care. A wide variety of solutions are used across healthcare including tap water, sterile water, sterile saline and hydrogen peroxide 10w/v (3%). Evidence to support the use of tap, sterile water or other solutions is equivocal and therefore local policies are highly likely to vary in their recommendations. This is acceptable from a patient safety perspective, but local practice should be influenced by the available water supply and quality, types of tubes used and patient condition. For most obtunded or acutely unwell hospital inpatients, sterile water would seem more appropriate.

It is important to note that the central rationale for cleaning of inner cannula is to mechanically remove debris which may physically obstruct a patient's airway. A secondary outcome of mechanical cleaning is a reduction in the numbers of microbes present. Inner cannulae can be cleaned at the patient's bedside.

It should be noted that there can be significant differences between the different manufacturers' tubes. Kapitex and Shiley tubes commonly require an inner cannula to be in place so that the tubes can be connected to a 15 mm standard anaesthetic breathing circuit. It is therefore essential that patients with these types of tubes *in situ* have a spare inner tube with them at all times. Videos demonstrating these differences can be accessed by viewing the url present in the footnote.[6]

Disposable inner cannulae are also available from some manufacturers and can improve the ease and subsequent compliance with inner tube care. There is an associated cost and environmental consideration but this may be expected to improve with newer material technologies.

Equipment in addition to standard bedside equipment includes:

- clean, disposable gloves
- clean and dry replacement inner cannula
- tracheostomy cleaning devices (sponges or brushes)
- fragrance-free detergent
- cleaning solution: tap water, sterile water or sterile saline (refer to local guidelines from infection control department)
- clean and dry covered container for spare inner cannula.

Procedure

Cleaning an inner tube is a relatively straightforward procedure. The inner cannula is removed and inspected. If clean, it can simply be replaced. If it needs to be cleaned, then a spare tube should be inserted at this point. Patients will therefore have one inner tube *in situ* and one at the bedside being cleaned or drying. Dedicated cleaning packs are commercially available, which makes cleaning quicker and easier (and often more likely to occur).

The tubes should be visibly clean and this can usually be achieved with saline and a foam brush or gauze. Abrasive wire brushes may cause scratch marks on the inside of the tubes and risk colonisation. The tubes are then left to dry in a suitable container. It is essential that the tubes do not sit in water as this may lead to bacterial growth.

Disposable inner tubes are increasingly available and affordable.

Videos demonstrating changing an inner cannula can be accessed in the links given in the footnotes, or by visiting the e-learning section of the website www.tracheostomy.org.uk.

- YouTube video of inner tube changes[7]
- narrated e-learning link[8] (requires flash player)

Documentation

Documentation should include accurate records of inner cannula care in the required format within the patient's record as per local guidance. Ensure handover of all information, reporting any problems in changing the inner cannula or missing inner cannulae.

Summary

Table 5.4 summarises key actions related to stoma care and their rationale (adapted from the NPSA expert working group).

Table 5.4 Inner cannulae—key actions to be taken and their rationale.

Action	Rationale

Explain and discuss procedure with the patient as appropriate	To relieve patient anxieties and gain patient consent and cooperation
Clean hands and apply appropriate personal protective equipment, PPE	To reduce the risk of cross-infection
Perform tracheal suction if necessary	To ensure airway is clear prior to procedure commencing
With one hand stabilise the outside of the tracheostomy tube; remove inner tube with the other hand	Removal of the inner tube with minimal movement of the tube on inner cannula removal
If the inner tube is clean and clear of secretions, simply reinsert	No further cleaning required
If there is difficulty in removing the inner tube, call for help from an appropriately trained healthcare professional	Dry tenacious secretions or granulation may prevent the inner tube from being removed and this requires prompt attention
If inner tube requires cleaning, replace with clean/spare inner cannula while cleaning is taking place	The tracheostomy tube should always have an inner cannula in place to prevent tube blockage
If the inner tube is fully or partially blocked with secretions, flush with locally agreed cleaning solutions and, if necessary, use a tracheostomy cleaning sponge or brush	To remove debris that may block the tube as this may become a source of infection Cleaning devices should be used with caution and care taken not to cause abrasion to the inner surface of inner cannula
If tube is coated with dried-on secretions, it may need to be disposed of and a replacement cannula placed at bedside	Excessive cleaning can damage the cannula and the cannula should not be left to soak as it is an infection risk
Rinse the inner cannula through with sterile water	To remove secretions and reduce infection risk
Shake excess water off inner cannula and place in covered clean container to dry prior to re-use	To ensure a clean and dry inner cannula is available for use
Ensuring the cannula is locked into place as per the manufacturer's instructions	To prevent the cannula dislodging

Observe amount and consistency of secretions	To observe for signs of infection or inadequate humidity

Oral care and swallowing

Oral care is important as it has a role to play in preventing healthcare-associated infections. Dental plaque and the oropharynx can become colonised by bacteria and a 'biofilm' can develop on the inside of airway devices. Secretions can also pool in the sub-glottic region. Normal oral airflow is disrupted when gas is directed through the tracheostomy and this leads to reduced evaporation of oral secretions, which subsequently accumulate in the mouth.

Patients who are able to should be encouraged to maintain their own oral hygiene by using a toothbrush and using mouthwashes. Incapacitated patients should have a daily assessment of their buccal mucous membranes to observe for bacterial, viral or fungal infections, skin tears or ulceration.

Aspirated infective saliva can contribute to respiratory problems. If the patient has a dry mouth, then consider artificial saliva.

Any obvious dental problems should be assessed promptly by an oral hygienist. There is an increasing amount of data in the literature which suggests that simple measures such as teeth cleaning and intermittent removal of oral secretions can have a significant impact on hospital-acquired infections, such as ventilator-associated pneumonia.

Specific oral care measures

These are among the oral care measures to be followed.

- Encourage self-care when possible.
- Patient's teeth should be brushed with a toothbrush and toothpaste at least twice a day.
- Chlorhexidine mouth washing should be done twice per day (not immediately after tooth brushing).

- There is no reason why patients with tracheostomies can't wear their dentures.
- Showering is permitted.

Dedicated commercial oral care packs are available, which may improve compliance with mouth care bundles.

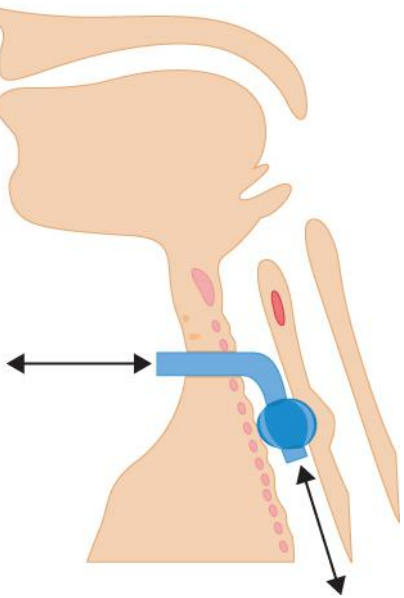
Swallowing

Most people with a new tracheostomy will have a nasogastric tube or similar feeding route and regimen established. The cuff of the tracheostomy or the tube itself interferes with the swallowing mechanics of the larynx. These muscles can waste if not used (during prolonged ventilation or immobility) and require careful rehabilitation and assessment. The SALT is an essential member of the multidisciplinary team.

Figure 5.12 shows an inflated tracheostomy tube. The cuff is pressing on the oesophagus behind the trachea, offering a physical obstruction to swallowing. The tracheostomy tube tethers the anterior structures of the neck and limits the amount of movement of the larynx and upper airways that is required for normal, safe swallowing.

Figure 5.12 The cuff of the tracheostomy tube can be seen to be impinging on the oesophageal lumen.

Reproduced with permission of HEE eLfH.



Patients with a tracheostomy tube are at high risk of developing swallowing difficulties, although some patients can swallow normally. The patient's underlying medical condition may compound swallowing difficulties. Assessment of the safety of the swallow is necessary as swallowing difficulties (dysphagia) can result in aspiration and the complications arising from this. A patient with a tracheostomy tube may have difficulty swallowing secretions as well as food and drink.

It may be possible to eat and drink with an inflated tracheostomy tube cuff *in situ*. It may be appropriate to embark on a trial of enteral oral intake if the patient's general clinical condition allows. There are a number of predictors of tracheostomy-related swallowing problems. The presence of any of the following should prompt referral to an appropriate SALT team.

- Following head and neck surgery
- Lower cranial nerve palsies (bulbar palsies)
- Clinical signs of aspiration (associated with attempted oral intake)
    - Coughing
    - Desaturation
    - Suctioning of particulate matter from the tracheostomy

- Weak, ‘wet’ or ‘gurgly’ voice heard during trials of cuff deflation.

Any formal assessment of swallowing will include a trial of cuff deflation (if present) to assess the function of the larynx. The parent team should have adequate knowledge of the individual patient's condition, including indication for the tracheostomy, current nutrition and respiratory status and weaning plan before assessment. Those caring for the tracheostomy patient must also have a sound understanding of the signs of swallowing difficulties and must be able to take necessary actions in the event of an emergency.

As the process of assessing the safety of the swallow is not without risk, the screening assessment and management of dysphagia must be carried out by an appropriate dysphagia-trained practitioner.

Assessment tools

Assessment usually involves attempting to normalise as much swallowing physiology as possible before examining and assessing how the patient manages trials of swallowing. This can be clinical assessment, or direct visual assessment using a suitable endoscope (Figure 5.13). Videos of fibreoptic endoscopic evaluation of swallowing (FEES) tests are housed within the e-learning modules at www.tracheostomy.org.uk.

Figure 5.13 A fibreoptic endoscope used in FEES testing.

Ideally, the patient will have the cuff deflated and be wearing a speaking valve during assessment of secretion tolerance and oral intake. This is to help restore more normal physiology to the upper airway and provide the practitioner with more clinical indicators of swallow safety.

The use of ‘blue dye’ to test swallowing and aspiration is not generally supported by evidence because of a high false-negative rate. The patient must be deemed safe at tolerating secretions before assessing for tolerance of oral intake. Aspiration of secretions is significantly linked to aspiration of oral intake. Patients that are nil by mouth, or are at risk of aspiration, should have a strict programme of oral care in place, as discussed, to help reduce the incidence of infection.

The following are the ideal circumstances under which to assess the swallow for tolerance of secretions and oral intake.

- The patient should be alert.
- The patient should be sat upright (if medically able).
- The oral cavity should be clean and clear.
- The tracheostomy tube cuff should be deflated (if present).
- A speaking valve should be attached.

Signs of dysphagia to be aware of during and after assessment/intake are:

- coughing or choking (N.B. patients may 'silently' aspirate)
- increased work of breathing
- fatigue
- change in the voice quality, for example, sounds wet
- noteworthy decrease in O_2 saturation levels and/or change in skin pallor
- deteriorating chest status
- increase in frequency of suctioning required
- evidence of aspirated material on suctioning
- loss of saliva or food/fluid from the mouth
- holding of saliva or food/fluid in the mouth
- patient reports difficulty swallowing.

Video fluoroscopy is a radiological investigation that involves ingestion and attempted swallowing of a radioopaque dye. X-ray screening is performed, which can follow the contrast in real time as it is swallowed. Pooling, hold ups and tracheal aspiration can all be detected using this method. Some modern imaging devices can screen at the bedside, but most patients will require a visit to the radiology department to have this test performed (Figure 5.14).

Figure 5.14 Radiographic screening of swallowing revealing an oesophageal stricture.

Therapies

If dysphagia is diagnosed, it may be possible to instigate tailored interventions with the aim of improving the swallowing. These include:

- 'training' the larynx with increasing trials of using a speaking valve in an attempt to normalise airflow through the larynx and restore normal physiology
- swallowing exercises
- reducing the size of the tracheostomy tube (if possible)
- using certain types of diet (e.g. thickened liquids)
- treating the underlying condition.

Often, the problems are multi-factorial and linked to the underlying condition. Any general muscle weakness may manifest as swallowing difficulties. Attention to nutrition, mobilisation and improving the general condition of the patient will often improve swallowing with time. Repeated assessments are usually indicated, the timing of which will be individual (days to weeks).

Documentation

Outcomes of the assessment of swallowing secretions and oral intake must be clearly documented in the patient's notes. Documentation must convey to other members of the multidisciplinary team (MDT) the findings of the assessment and the resulting recommendations. The entry should also ensure accurate reporting of any adverse reaction the patient experienced with the procedure and actions taken or still required. If referral to a specialist dysphagia practitioner (e.g. SALT) is required, or has been made, this must be documented.

Summary

Table 5.5 summarises key actions related to swallowing assessment and their rationale (adapted from the NPSA expert working group).

Table 5.5 Swallowing assessment—key actions to be taken and their rationale.

Action	Rationale
Explain and discuss the procedure with the patient	To ensure consent, understanding and reduce anxiety
Have communication aids available, for example, alphabet chart, pen and paper, interpreters if necessary	To promote effective two-way communication
Sit the patient upright (unless contraindicated)	To promote chest expansion and help reduce aspiration risk
Suction the patient if necessary	To remove secretions prior to cuff deflation
Perform cuff deflation while suctioning and observe for signs of acute respiratory distress, desaturation or patient discomfort. Inflate cuff if not tolerated and agree on review date; this may be as frequently as daily	To ensure the patient is able to tolerate the secretions prior to proceeding to oral intake
If cuff deflation tolerated, attach the speaking valve if applicable to the patient's individual weaning plan, following local policy	To optimise the physiology of upper airway and provide

	additional clinical indicators of dysphagia
Assess voice quality; proceed to fluid challenge below if voice adequate	Detect signs of failure to manage oral secretions
Trial initially with sips of water, observing for signs of dysphagia	To optimise progression to oral intake and to reduce risk of aspiration
If signs of aspiration are observed, cease trials and refer to a specialist dysphagia practitioner, ideally a speech and language therapist	
If trials are successful, progress cautiously to oral intake as each consistency is deemed safe	
Remove speaking valve and re-inflate the cuff post assessment/trial according to the patient's individual weaning plan	To optimise weaning success and reduce patient risk
Involve MDT throughout the process, including the patient and their family	To optimise success and reduce patient risk

Cuff management

It is usual that the initial tracheostomy tube to be inserted will be a cuffed tube. The cuff provides a sealed airway. A cuffed tube is usually a temporary measure until a patient is weaned from a ventilator and the patient can control own secretions, but may be required long term if the underlying condition does not improve sufficiently. Examples include:

- patient requires long-term ventilation, either continually or intermittently (e.g. overnight)
- patient has a reduced conscious level or neuromuscular or mechanical problems affecting the pharynx; the airway is at risk of aspiration of gastrointestinal (GI) contents and a cuffed tube can provide a degree of protection against this
- patient has excessive oral secretions that cannot be managed by the patient's own efforts.

Management of the cuffed tracheostomy tube focuses on the appropriate management of the distal cuff. Tracheal capillary pressure lies between 20

and 30 mmHg and an impairment of this blood flow will be caused by an obstruction between 22 and 37 mmHg. The complications from the continued use of an overinflated cuff include:

- tracheal stenosis (scarring and narrowing of the trachea)
- tracheomalacia (the cartilaginous structure of the trachea becomes weakened and the trachea is prone to collapse)
- tracheo-oesophageal fistula (an unplanned communication between the rear wall of the trachea and the oesophagus which lies behind; this can lead to GI contents contaminating the airway)
- tracheo-inominate artery fistula—an artery near the trachea can be damaged because of prolonged pressure.

In addition, a patient with an inflated cuff may experience desensitisation of the larynx, a reduced cough reflex and loss of voice or sound production.

Too low a cuff pressure will cause an air leak and lead to ineffective positive pressure ventilation. The cuff will develop longitudinal folds that permit microaspiration of secretions which have collected above the cuff. This subsequently increases the risk of nosocomial pneumonia. The accepted pressure is the minimum pressure required to prevent a leak but which must not exceed 35 cm H_2O. Recommendations suggest that the cuff pressure should be kept between 15 and 25 cm H_2O (10–18 mmHg). Regular cuff pressure checks are carried out every 8-h shift.

Cuff leaks

A cuff leak can vary in its significance from being irritating to the staff and the patient, owing to ventilator alarms, through to life-threatening complications from aspiration or ventilation failure. The leak can come from a number of sources and, importantly, may be associated with a partially displaced tube.

Sources of leaks include:

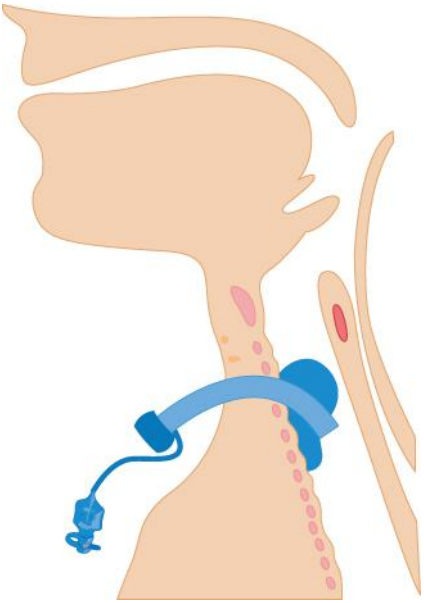
- defective or damaged cuff (sometimes on insertion of the tube)
- cuff not adequately inflated (see preceding text)
- patient requires high ventilator pressures and/or positive end expiratory pressure/continuous positive airway pressure (PEEP/CPAP) that exceed the sealing capacity of the cuff

- tube does not fit the airway
    - simply too small
    - positional changes cause a leak
    - tracheomalacia or wound breakdown.

Simply adding more air to a cuff or precariously positioning the tube or patient is not a solution to an intermittent cuff leak. Sometimes the weight of an attached ventilator circuit may contribute to partial displacement of a tube; therefore, when assessing the patient to locate the source of the cuff leak, remember to think about problems that may not be directly associated with the tube. A fibreoptic inspection of the tube, stoma or trachea may be indicated if clinical assessment cannot determine the source of the problem. A trial of a different or a larger tube may be indicated. If the patient is receiving high levels of respiratory support or oxygen, the decision to change a tube is balanced against the risks of leaving a potentially unsecured airway device *in situ* (Figure 5.15).

Figure 5.15 Positional changes in the tube may cause a leak.

Reproduced with permission of HEE eLfH.



Patient assessment: cuff deflation

The decision to trial cuff deflation should be made by appropriate members of the MDT and carried out and monitored by appropriately trained and skilled staff. The occasions when cuff deflation may be required include:

- prior to tube removal
- prior to assessment of patients' ability to manage oral secretions
- prior to eating or drink (where swallowing is assessed as safe)
- in a patient using a speaking valve or occlusion (decannulation) cap
- as part of a structured weaning programme.

Patients who have extremely limited respiratory reserve may not tolerate cuff deflation well, despite having been free from ventilator support for some time. The patient will start to move gas through their mouth, nose and upper airways once the cuff is deflated. These are simply conduction airways and do not contribute to gas exchange. It takes an extra effort to shift the gas through this 'dead space' once the cuff is deflated. Also, inspired air via the mouth will dilute any oxygen given via the tracheostomy and may lead to a drop in the oxygen concentration reaching the lungs, contributing to hypoxia. Finally, the tube in the trachea offers resistance to airflow, which requires respiratory effort to overcome when the patient breathes past this partial obstruction via the upper airways. The consequence is that cuff deflation is not always a benign process and patients must be adequately monitored.

Procedure: cuff deflation

It is recommended that two people are required for this procedure. Any secretions that may have collected above the cuff of the old tube need to be removed prior to cuff deflation. This reduces the risk of contamination of the airway. In the sedated patient, this will involve oral, pharyngeal and sub-glottic suction with a soft catheter. Awake patients will find this uncomfortable, but it is important to remove secretions from above the cuff if possible. Tubes with specific sub-glottic suction channels allow some of the secretions to be cleared more easily. Any remaining secretions can be removed by timing cuff deflation (prior to tube removal) with expiration. The patient is asked to take a breath in and exhale strongly or

cough as the cuff is deflated. If the patient is ventilated, then deflation is timed with the expiratory phase.

The cuff is deflated with simultaneous suctioning, to remove any material that may have accumulated above the cuff and remains, despite the sub-glottic suctioning.

Documentation

Document cuff pressure checks at least once per shift, or in accordance with local guidelines. Ensure handover of all appropriate information, reporting any problems in measuring cuff pressures.

Figure 5.16 Cuff pressure can be accurately measured using a manometer.

Summary

Table 5.6 summarises the key actions related to cuff management and their rationale (adapted from the NPSA expert working group)

Table 5.6 Cuff management—key actions and their rationale.

Action	Rationale
Explain and discuss procedure with the patients as appropriate; explaining that they can expect to experience the movement of air and secretions within the upper airway and may be able to make audible sounds	Allay patient anxieties where possible

Suction via tracheostomy and/or mouth (where necessary)	To remove secretions prior to cuff deflation
Deflate the cuff slowly using a clean syringe to aspirate air from the cuff via the pilot balloon	To deflate cuff
Perform tracheal suction as necessary while deflating cuff	To exclude the risk of aspiration of secretions
Assess patient comfort, respiratory rate and oxygen saturation throughout the procedure	To identify significant changes in respiratory pattern which may indicate cuff re-inflation
Assess the need for re-inflation and reinflate if required	To alleviate respiratory distress experienced with cuff deflation

Changing tracheostomy tubes

Changing the tracheostomy tube should be a multi-disciplinary decision. The first change should always be performed or supervised by a suitably trained member of the medical staff. Videos of tube changes[9] can be found here.

Knowledge and understanding

In order to change a tracheostomy tube safely and appropriately, the practitioners must appreciate the specific clinical indications for the original formation of the individual patient's tracheostomy. In addition, they will need to know when and how the tracheostomy was formed. It is considered that a newly formed tracheostomy will close more quickly than an established tracheostomy tract, and indeed, within the first 48 h of a surgical tracheostomy, or 7–10 days of a percutaneous tracheostomy, extreme caution must be taken as a tube change may be difficult, or even impossible.

Patient assessment

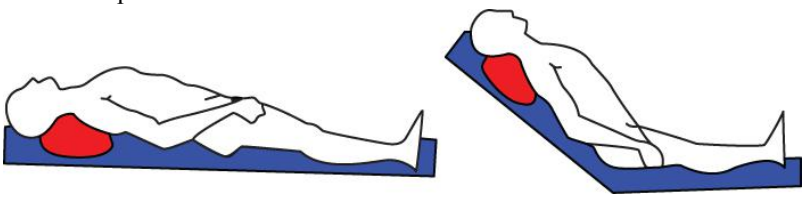
Indications to change a tracheostomy tube include:

- the tube having been *in situ* for the maximum recommended duration: 30 days for tubes with a removable inner cannula (most manufacturers' recommendations) and 7–10 days for single-lumen tubes
- facilitating weaning by inserting a smaller, uncuffed or fenestrated tube
- the patient needing ventilatory support or resuscitation and requiring a change from an uncuffed to a cuffed tube
- improving fit or comfort of tube
- replacing a faulty tube
- resolving a misplaced or displaced tube.

A tube change may be contraindicated if the patient:

- is in an unstable clinical condition (balancing risks/benefits)
- requires high levels of ventilatory support or oxygen
- has a high risk of losing the airway
- had a tracheostomy within the past 7 days, especially if percutaneously formed
- is undergoing radiotherapy to the neck region (or has completed course in past 2 weeks)
- is under palliative care, where quality of life will not be improved by tube change
- refuses the procedure.

Figure 5.17 Careful positioning can bring the trachea into a more accessible position.



Each tracheostomy tube change and each patient should be assessed individually prior to each and every tube change, balancing the risks and

benefits. The procedure will require two competent practitioners and more, especially if the patient becomes agitated during the procedure.

Particular caution needs to be taken in the following circumstances:

- first tube change
- difficult previous tube change
- patient has a known obstructed or difficult upper airway (this is the 'back up' airway in case of difficulties with the stoma)
- early changes (within 2–4 days of surgical tracheostomy and 7–10 days of percutaneous tracheostomy)
- patients with a large neck
- patients requiring high levels of ventilator support
- patients requiring high concentration of inspired oxygen
- patients with tumours surrounding the tracheostomy tract
- patients with significant granulation tissue around the stoma site
- agitated or combative patients.

N.B.: If a difficult tube change is anticipated, then a clinician experienced in upper airway management (including endotracheal intubation) and a clinician or practitioner proficient and experienced in managing tracheostomy tubes should be present. All relevant equipment and emergency anaesthetic drugs should be available. Plan for loss of airway and failure to cannulate the tracheostomy.

Most tube changes are uneventful, but those that don't go smoothly can go badly wrong. Thorough preparation is essential. Following a successful initial change of tube, subsequent tube changes can be performed by a competent and suitably trained person **but medical assistance and emergency equipment should be readily *available* at all times**. The *availability* depends on your risk assessment of the clinical situation. It is essential to record how you changed the tube and any complications that arose. This record should also document recommendations for subsequent tube changes, such as timing and whether any particular equipment or personnel are required. If the tube change was straightforward, this is useful information to pass on also. Record any important details on the bedhead sign.

The tubes may be changed like-for-like, changed for a different type of tracheostomy (e.g. fenestrated tube or a different brand), changed for a smaller tube (downsizing) or removed completely (decannulation).

Equipment required for a tracheostomy tube change

This includes:

- two tracheostomy tubes of appropriate make
  - one same size, the other one size smaller
- dressing pack
- normal saline (0.9%) to clean
- 10 ml syringe and cuff pressure manometer if the tube has a cuff
- suction equipment and suction catheters
- sterile gloves and protective eye wear
- water-soluble lubricating gel
- tracheal dilators (local or individual preference)
- pen torch
- tracheostomy tube tapes, ties or dedicated holder
- stoma dressing
- stitch cutter if previous tube has been sutured
- new closed suction system (this is a good opportunity to change to clean ancillary equipment)
- microbacterial swab of the stoma site may be indicated
- an exchange device such as an Aintree catheter or Bougie may be required
- waveform capnography (essential if the patient is ventilator-dependent, or a difficult procedure is expected)
- resuscitation equipment
- fibreoptic scope available
- oxygen supply and appropriate masks to deliver oxygen to face or stoma
- oxygen saturation monitoring
- stethoscope.

Patient preparation

Gaining the patient's trust and cooperation is essential. This is not always possible in the sedated, neurologically impaired or combative patient, but

an explanation should always be attempted. The patient is likely to cough, feel a tugging and a pushing sensation in the neck and have bloodstained secretions afterwards, but can be reassured that the procedure usually lasts less than 1 minute.

Some patients will benefit from a sedative or analgesic premedication. The risks of this should always be balanced against the benefits and sedation should be prescribed and administered by an appropriate person. Sedating patients who are not breathing fully independently or have a high requirement for oxygen should only be done in an appropriate environment. Full resuscitation equipment should be available. Using sedation may mean that future tube changes become more complex to arrange and facilitate.

Local anaesthetic gel can also be applied to the stoma for a few minutes prior to the procedure. Lubricating the new tube with local anaesthetic gel will improve any immediate post-procedural discomfort.

Pre-oxygenation is essential before a tube change of patients with oxygen or ventilator dependency, or those in whom the difficulty of the change is unknown.

Owing to the risk of vomiting and aspiration associated with tube changes and airway manoeuvres, patients should ideally be ‘nil by mouth’ for 6 h for solids, and 2 h for clear liquids before an elective tube change. If a patient has had many tube changes before without incident, then these guidelines could be reasonably relaxed. Patients fed via a tube feeding system should have this stopped and aspirated, and any gastric drainage tubes *in situ* should be aspirated also.

Positioning the patient with the neck extended brings the trachea anteriorly. This should be done for all patients unless contraindicated (e.g. cervical spine injury). Tube changes can be performed with the patient supine or reclined in a suitable chair or bed, depending on the clinical condition. The role of stay sutures should be identified, if present, as these may elevate and widen the stoma.

Any secretions that may have collected above the cuff of the old tube need to be removed prior to cuff deflation. This reduces the risk of contamination of the airway. In the sedated patient, this will involve oral, pharyngeal and sub-glottic suction with a soft catheter. Awake patients

will find this uncomfortable, but it is important to remove secretions from above the cuff if possible. Tubes with specific sub-glottic suction channels allow some of the secretions to be cleared more easily. Any remaining secretions can be removed by timing cuff deflation (prior to tube removal) with expiration. The patient is asked to take a breath in and exhale strongly or cough as the cuff is deflated. If the patient is ventilated, then deflation is timed with the expiratory phase.

Changing the tube

An elective change of a tracheostomy tube can be performed using essentially two techniques: a 'blind' technique where the new tube is inserted directly into the old stoma or a 'guided' technique using a wire or bougie to remove the old tube and 'railroad' the new tube over. There are slight variations in these techniques for different circumstances. Videos of tube changes are provided here and there is a section on the e-learning part of the website www.tracheostomy.org.uk.

Tube changing videos may be found in the urls given in the footnotes:

- Removing a tracheostomy tube (narrated)[10]
- Decannulation and application of oxygen to the stoma[11]
- Tube changes over a bougie[12]
- Fibreoptic inspection of a tracheostomy tube[13]

'Blind' insertion

For well-established stomas that have had uneventful tube changes documented previously, changing the tube by simply removing the existing tube and reinserting the new tube into the stoma is an accepted technique. The new tube is prepared by leaving the 'obturator' *in situ*, as shown in Figure 5.18 (purple piece in this image). This provides the tube with a smooth, tapered profile as it enters the neck.

Figure 5.18 The 'obturator' to be left *in situ* while the new tube is prepared.

Reproduced with permission of HEE eLfH.

The tube is initially introduced with the tracheal portion ‘flat’ to the stoma as shown in the Figure 5.19. Once the trachea is entered, the tube is rotated through 90° to enter the trachea. This rotation should not occur before the tube is within the trachea as this risks creating a ‘false passage’ in the anterior tissues of the neck.

Figure 5.19 Tube insertion.

Reproduced with permission of HEE eLfH.

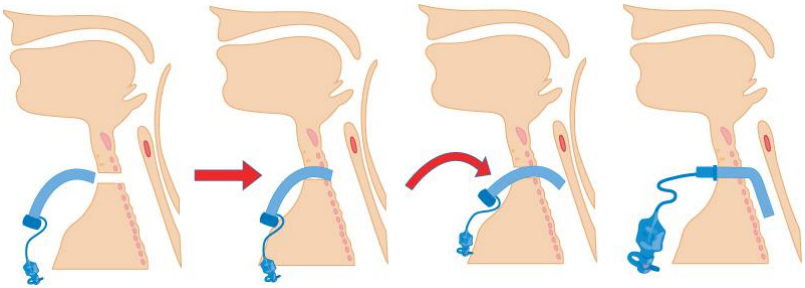
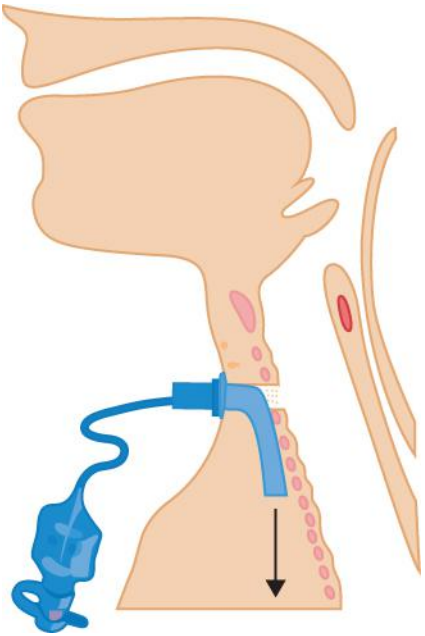


Figure 5.20 shows a tube which has been placed into a false passage. The tube lies in the anterior tissues of the neck. Attaching the tube to any sort of gas supply and attempting ventilation could rapidly result in airway obstruction, pneumothorax, pneumomediatinum or subcutaneous (surgical) emphysema, which could rapidly become life threatening. This also means that the stoma is not effective as a means of oxygenation and the trachea itself could be compromised.

Figure 5.20 This tube has been incorrectly placed into a false passage.

Reproduced with permission of HEE eLfH.



'Guided' tube changes

For the first tube change, or if there is either an unknown or predicted degree of difficulty in changing the tracheostomy tube, the exchange is usually performed over a guide. This can be a gum-elastic bougie, an airway exchange catheter, a guide wire or suction catheter. The principle is to insert the guide into the trachea via the old tube and leave it *in situ*

when the old tube is removed. This ensures that the path from the skin, through the tissues of the neck to the trachea remains 'marked' and should make insertion of the new tube easier. This technique is especially useful if the patient has a relatively new tracheostomy stoma or the neck is large, making the stoma deep. The superficial and deeper layers in the neck may 'spring' back into their anatomical positions following removal of the existing tracheostomy tube. Using a guide will help to reduce the impact of this.

A selection of guides suitable for this purpose is shown in Figure 5.21. It should be remembered that this technique relies on the old tube being correctly placed within the tracheal lumen when the guide is inserted. If there is any doubt about this, a fibreoptic inspection is recommended. Some airway exchange catheters can be first loaded over a suitable fibreoptic endoscope so that the catheter's position within the airway is confirmed visually. New tubes can be railroaded directly over a 'scope', but scopes are more easily damaged than a cheap, disposable bougie.

Figure 5.21 From left to right: fibreoptic scope, suction catheters, guide wire and gum-elastic bougie.

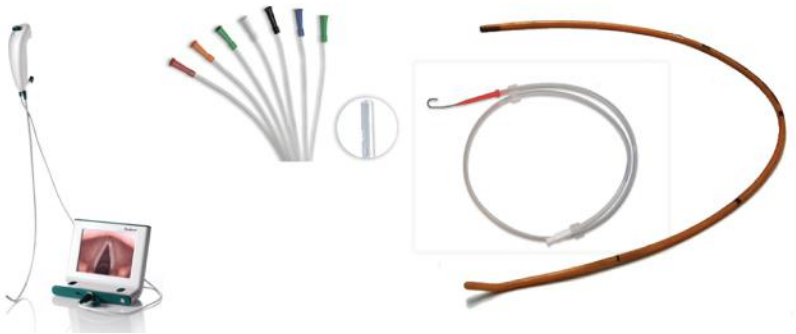


Figure 5.22 shows a bougie inserted into a tracheostomy tube. Because this is potentially unpleasant for the patient and risks trauma to the trachea, coughing or irritation of the carina (with associated vagal side effects), the bougie should be inserted for as short a time as possible. This means preparing the patient by first removing the dressings around the tube and the sutures or ties that hold the tube in place. The bougie should be held by a dedicated assistant, so that another 'pair of hands' concentrates on cuff management and tube exchange. It is useful to have a

'talk through' rehearsal between operators before undertaking the procedure.

Figure 5.22 A bougie inserted into a tracheostomy tube.

Gum-elastic bougies are not primarily designed for tracheostomy tube exchanges. Several specific airway exchange catheters are available. Some of these allow connection to standard anaesthetic circuits to allow oxygenation during the exchange procedure and some have a large enough internal diameter to allow a fibreoptic scope to be inserted as previously described. Figure 5.23 shows a Cook Aintree catheter connected to a 15 mm port.

Figure 5.23 A Cook Aintree catheter connected to a 15 mm port.

What to do if the new tube won't go in

Sometimes, new tubes won't insert easily. It is important not to force a new tube into a stoma. Similarly, blindly attempting to pass a bougie or introducer into a deep or fresh tracheostomy stoma may lead to the

creation of a false passage, cause bleeding and delay attempts at more conventional airway management.

The key principle is to maintain oxygenation by whatever means necessary. In the elective situation, this may be as simple as reassuring the patient and awaiting a more experienced practitioner. In the oxygen- or ventilator-dependent patient, this can be more arduous. All necessary equipment, drugs and personnel should be on hand to manage this situation if the patient and clinical area have been adequately prepared.

The commonest solution to this problem is to insert a new tube that is a size smaller than the tube that has been removed. If necessary, the stoma can be formally dilated at a later time. If your experience and local guidelines allow, tracheal dilators (Figure 5.24) may be used to temporarily dilate the stoma while a new tube is inserted.

Figure 5.24 Tracheal dilators.

If the patient has a patent upper airway, oxygen should be applied to the face while more invasive attempts at intubating the stoma are made. The goal is a safely oxygenated patient, and a formal reinsertion of the tube may need to occur in a planned manner in an operating theatre environment. If the clinical condition of the patient means that tube exchange needs to be more urgent, options include:

- identification of the tract and trachea using a fibreoptic scope

- a scope and airway exchange catheter
- digital manipulation of a bougie into the trachea[14]
- blind passage of a bougie or guide wire into the stoma
- formal refashioning of the stoma surgically or percutaneously.

A video demonstrating cannulation of a stoma using an Aintree catheter and fibreoptic scope is available here.[15] There is more detail on managing a deteriorating tracheostomy or laryngectomy patient whose airway is compromised in the emergency management section.

Summary

Table 5.7 summarises key actions related to tube changes and their rationale (adapted from the NPSA expert working group).

Table 5.7 Tube changes—key actions and their rationale.

Action	Rationale
Identify need for tracheostomy tube change and clarify type of tube to be inserted	To ensure tube change is necessary and the correct tube type is selected for current and ongoing patient care needs
Patient preparation may include ensuring 'nil by mouth' for 2–6 h (liquid–solid) and/or aspirate gastric tube	To limit the risk of aspiration during tube change procedure
Decide on blind or guided technique and assemble appropriate equipment	Guided techniques more appropriate for first or (potentially) difficult exchanges
Explain the procedure to the patient and obtain verbal consent if appropriate	To ensure the patient understands the procedure and improve cooperation
Ensure appropriate staff and equipment are available	To deal appropriately with additional measures to secure an airway
Set up bedside suction and oxygen equipment	To ensure oxygen and suction are available (when needed)
Prepare, check and lubricate new tube Remove any inner cannulae from both old and new tubes	To ensure new tube has no faults and is prepared for insertion and application

Remove any obstructing clothing or equipment	To ensure neck area is accessible for tube change
Position patient for procedure by placing a roll under the patient's shoulders, extending the stable neck Patient may be placed lying down or sitting upright depending on individual patient assessment	To bring the trachea closer to the skin and to stretch stoma opening in order to aid tube insertion
Identify the roles of any stay sutures	Elevate and open the stoma
If the tracheostomy tube is sutured *in situ*, remove all sutures; skin sutures may be considered for removal if appropriate	To allow tube removal and to prevent sutures becoming embedded or an infection risk
Pharyngeal and sub-glottic suction orally or via dedicated port on tube	Reduces the risk of aspirating collections above the cuff
Deflate cuff (if present), simultaneously suctioning	To enable existing tube to be removed and for secretions to be cleared
Untie tapes and remove dressing while tube is held firmly in place	To remove old dressings and tapes
Insert guide via old tube (if used)	Maintains patency of stoma
Remove existing tube with a firm out and downwards movement as patient breathes out	To reduce patient coughing
Observe stoma site and tracheal opening	To identify signs of infection, granulation tissue and/or bleeding
Holding the introducer (obturator) in place, insert new tube directly into stoma *or* using the guide, railroad the new tube	To pass tube along contour of tract
Remove introducer/guide	To allow patient to breathe and to allow confirmation of correct tube position
Check correct positioning: • Ask patient to breathe out, air should be felt through end of tracheostomy • Auscultate	Evidence of airflow exiting the tube will confirm correct placement within the airway

• Bilateral chest movement • Suction below the end of the tracheostomy to confirm placement within trachea • Capnography[a] • Fibreoptic endoscopy	
Following successful exchange:	
Re-attach any oxygen or ventilation needs Inflate cuff and check cuff pressure (as per guidelines) Apply tapes and dressing (as per guidelines)	To recommence respiratory requirements and secure tube position
Reposition patient as to patient requirements and comfort	To maintain patient comfort

[a]Capnography and endoscopy should be immediately available for difficult cases.

Weaning, downsizing and planning for decannulation

Tracheostomies may be only a short-term requirement for patients and should be removed as soon as they are no longer needed. Judging the timing of removal of the tube (decannulation) can be difficult, and the patient may need to spend several days, or even weeks, progressing towards this step. The best way to reduce complications from having a tracheostomy tube *in situ* is often to remove the tube as soon as it is safe to do so.

The term 'weaning' can mean either a reduction in support from mechanical ventilation (or assisted spontaneous breathing modes), a generic term for the period of time as the patient progresses towards decannulation, or the term is sometimes applied to a reduction in the size

of the tracheostomy tubes. The latter term is referred to as ‘downsizing’ in this manual.

Within the hospital setting, patients will be in one of three different categories with their tracheostomy: permanent tracheostomy (non-weanable), long-term (weanable with difficult or under specialist supervision) or temporary (weanable). Tracheostomy tubes may cause permanent anatomical or physiological damage to the airway and related structures and therefore timely weaning, where indicated, is advantageous.

Prior to the removal of a temporary tracheostomy tube, there must be MDT agreement that the indication for the tracheostomy has been resolved sufficiently. The weaning process must be clearly led by individuals who are competent to do so, as the process is not without risk. This same team should remain the main point of contact for at least 48-h post decannulation. If patient location prevents this being a viable option, care should be formally handed over to someone able to provide adequate advice and interventions.

A tracheostomy MDT will regularly include:

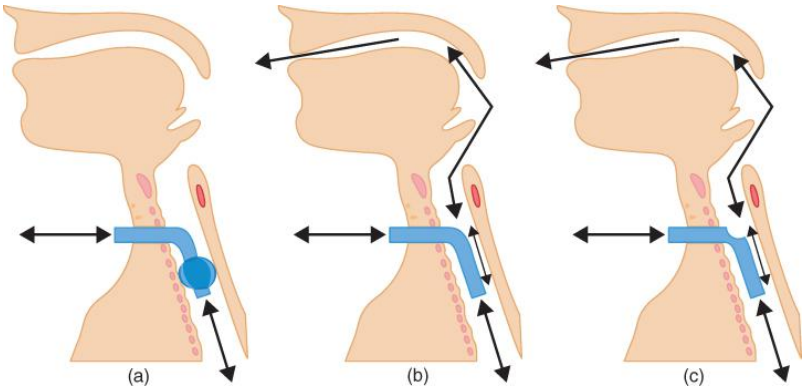
- ward nurse
- physiotherapist
- SALT
- specialist nurse [Tracheostomy, ENT or Critical Care, for example, Outreach]
- respiratory physician
- head and neck surgeon
- anaesthetist or intensivist
- the patient and/or their carer may be valuable team members with considerable knowledge; the patient will be included in any relevant discussions if possible.

The team must have a thorough knowledge of the individual patient's condition including indication for tracheostomy, established indicators for decannulation and plan of further future assessments or interventions. Practitioners caring for the patient through the decannulation process must have a sound understanding of the signs of deterioration during or post decannulation and must be able to take necessary actions in the event of an emergency.

For some short-term conditions requiring a tracheostomy (e.g. facilitating a straightforward wean from mechanical ventilation or covering extensive oral surgery), the original tracheostomy tube may suffice for the whole weaning process, prior to removal. In more complex situations, a smaller tube, a different type of tube (e.g. minitrach), a fenestrated tube or a variety of speaking valves or decannulation caps may be required. Figure 5.25 demonstrates expected airflows with cuffed, uncuffed and uncuffed, fenestrated tubes.

Figure 5.25 Expected airflows with cuffed tube (a), uncuffed tube (b) and an uncuffed, fenestrated tube (c).

Reproduced with permission of HEE eLfH.



Patient assessment

In assessing whether a patient is a suitable candidate to attempt weaning with an aim of decannulation, it must first be clarified whether the reason for the tracheostomy has been resolved. This may require assessment by endoscopy to assess patency of upper airway and movement of vocal cords. This can be carried out by anyone competent to do so, but may involve head and neck surgical teams, anaesthetists, intensivists or SALT teams who are usually more experienced with endoscopy. A more general assessment of the patient is also required to ascertain whether the patient is well enough to endure the removal of the tracheostomy within the coming days.

A checklist to use prior to commencing weaning should ascertain these aspects.

- Is the upper airway patent? (This may require endoscopic assessment.)
- Can patients maintain and protect their airway spontaneously?
- Are they free from ventilatory support?[16]
- Are they haemodynamically stable?
- Are they free of fever or active infection?
- Are the patients consistently alert?
- Do they have a strong consistent cough (able to cough into mouth)?
- Do they have control of saliva + /− a competent swallow?
- Are there any planned procedures requiring anaesthesia within next 7–10 days?
- Is this patient causing concern?
- Can we safely support the weaning process in the patient's current clinical environment?

The principles of weaning involve gradually returning the airflow patterns in the upper airways back towards 'normal', thus restoring normal physiological functions. This process will only succeed if the tracheostomy tube *in situ* is of an appropriate size to allow sufficient airflow around and/or through the tube to the upper airways.

The process

There are many variations on decannulation protocols described in the literature. It is not clear which of these is 'the best' or whether some work better in certain situations. If your institution has a protocol which works for your patients, then you are probably just as well continuing to work with it. We have attempted to explain here the principles behind the various strategies that may be employed.

The first step after determining suitability is to deflate a tracheostomy tube cuff, if present. This is in order to ensure the patency of the upper airway and to ensure that the patient can manage the upper airway secretions. Deflation of a cuff is explained in detail elsewhere in this manual. In summary, it involves prior sub-glottic and pharyngeal suctioning (or suction of a dedicated sub-glottic suction port) prior to cuff deflation with simultaneous suctioning.

If a patient has had a cuffed tracheostomy tube *in situ* for some time, then deflation and the subsequent flow of air through the upper airways (Figure 5.26) can cause some initial coughing or distress. The cuff may have to be deflated on a number of occasions for increasing time periods. If the patient is breathing significantly through the upper airways, then consideration should be given to the inspired oxygen concentration. Room air (21% oxygen) will be mixed with the concentration inspired via the tracheostomy and the oxygen concentration delivered to the lungs will be lower than that delivered. If the patient is oxygen dependent, this could lead to hypoxaemia. The oxygen concentration delivered to the tracheostomy can be increased, supplemental oxygen may need to be given by facemask or the cuff may need to be reinflated. Hypoxia usually indicates that the patient is not ready to proceed beyond short trials of cuff deflation.

Figure 5.26 Potential air flow with a partially deflated cuff.

Reproduced with permission of HEE eLfH.

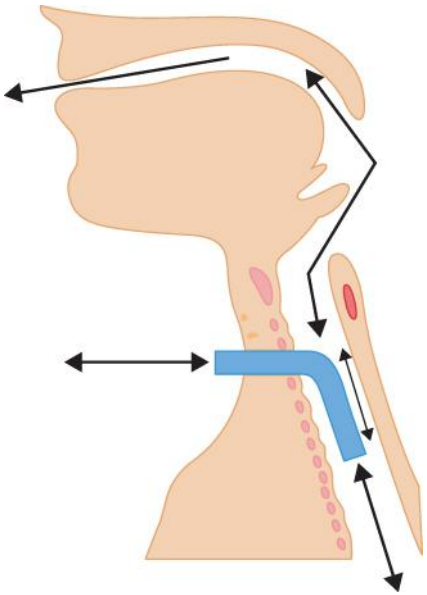


Figure 5.27 Varying tube size and the level of cuff inflation during weaning.

Reproduced with permission of HEE eLfH.

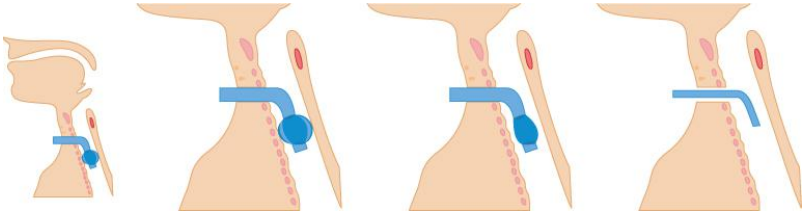


Figure 5.28 A selection of speaking valves and caps.

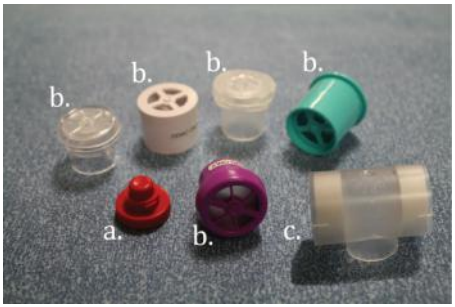
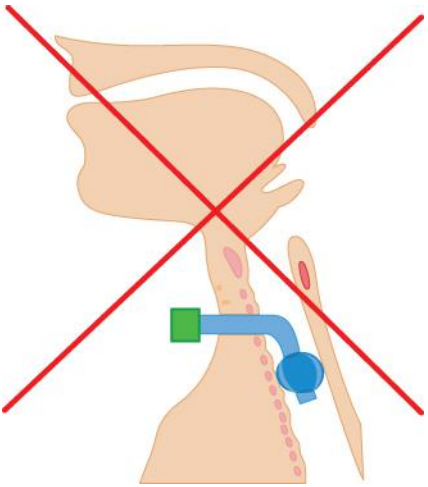


Figure 5.29 A speaking cap should never be attached to a cuffed tube when the cuff is fully inflated, as shown here, as the patient will suffocate.

Reproduced with permission of HEE eLfH.



If patients can tolerate cuff deflation, we will have established that they have a patent upper airway and that they can manage their oral secretions. Cough effort and swallowing can also be assessed at this point. If a patient has had a tracheostomy tube *in situ* for a prolonged period of time, cuff deflation should normally be tolerated for around 24 h prior to attempting further interventions and proceeding with the decannulation plan. Patients who are relatively well or who have had a short-term tube *in situ* may be able to progress rapidly if each step is well tolerated.

Occlusion of the end of the tracheostomy tube will mean that the patient has to breathe solely through the upper airways and all airflow in the trachea will have to be *around* the tube and not *through* it. With the tracheostomy tube and deflated cuff siting in the airway, this offers a significant resistance to airflow, associated with an increase in the work of breathing. Figure 5.29 shows the different amounts of space available to breathe around a tracheostomy tube sited in the trachea.

Digital occlusion with a gloved finger is a simple way to assess whether the patient is able to tolerate further attempts at weaning with the current tube *in situ*. If the patient can breathe adequately past the tube, in and out via the nose and mouth without any signs of respiratory distress, then weaning could reasonably progress with the same-sized tube. If the patient cannot breathe adequately via the upper airways, then the tube may be too large and downsizing to a smaller tube (Figure 5.27) may allow more gas to bypass the tube to the upper airways. This will offer less resistance to gas flow in the trachea. The largest tubes that will be tolerated for weaning in this way are usually 7.5 mm ID for males and 6.5 mm ID for females. Failure to tolerate brief tube occlusion must raise the possibility of upper airway obstruction, which should warrant fibreoptic inspection.

A fenestrated tube (with single or multiple holes on the outer curvature of the tube) may be useful for weaning, especially for patients who do not cope well with downsizing, or when downsizing is not possible. They are used as appropriate and caution must be taken as the fenestrations may cause the formation of granulation tissue within the trachea and/or allow trauma to the posterior tracheal wall if suctioned through inadvertently.

The choice of whether to leave a cuffed tube *in situ* or change to an uncuffed tube will depend on the patient and the circumstances. If the patient is only tolerating short periods of cuff deflation or if intermittent or nocturnal ventilation may still be required, a cuffed tube will need to

remain. Otherwise, an uncuffed tube will offer less resistance to flow to the upper airways.

When a patient is known to have a complex airway (e.g. requiring an adjustable flange tracheostomy) or has a previously documented difficult intubation, extra caution is taken throughout the whole process. In these cases, it is essential to liaise closely with the relevant parent team with responsibility for the tracheostomy.

Speaking valves and caps

Speaking valves and occlusion caps are advocated by many and can be used prior to tube removal. The speaking valves (labelled 'b' in Figure 5.28) are one-way valves, allowing gas to be inspired via the tracheostomy tube. The valve closes in expiration, forcing gas through the upper airways. A decannulation cap (labelled 'a' in Figure 5.28) blocks all airflow via the tracheostomy tube. Both of these systems cause an increase in the resistance to airflow through the trachea, as the tube is still present in the lumen of the trachea. Some patients will therefore tire even after a few minutes of this sort of intermittent or permanent occlusion and need the valve or cap to be removed. Monitor all of these trials carefully; if a brittle patient becomes fatigued, the weaning process may be delayed by several days while that patient recovers. They may not always be required if the patient has had a relatively short-term tracheostomy *in situ.*

One of the most important points to remember when using speaking valves or caps is that they must never be used with a cuffed tube with the cuff inflated. Outside of specialist areas, it is probably safer to stipulate that these devices should simply not be used with cuffed tubes at all, as even the potential to inflate the cuff with these devices attached can be fatal. The patient cannot exhale through the tracheostomy tube when a speaking valve is attached, and if the only alternative means of exhalation (via the upper airways) is blocked with an inflated cuff, the patient will suffocate. Both inhalation and exhalation via the tube are impossible when a cap is used. Videos explaining the use of speaking valves can be found here,[17] with a narrated e-learning presentation available here[18] (Figure 5.29).

Speaking valves can be used in breathing circuits with ventilators in some circumstances. Normally, ventilator-dependent patients do not tolerate attempts at speech, as this comes at the expense of oxygenation and appropriate ventilation. However, for some patients who are weaning from mechanical respiratory support slowly, or those who require long-term ventilatory support, attempts at speech may be appropriate. It is important to deflate any cuff that is used prior to inserting the speaking valve. The ventilator will usually have to be set to deliver larger tidal volumes. The subsequent loss of gas from the upper airways as it is exhaled via the larynx will cause most ventilators to assume that a significant circuit leak is occurring and the alarms should be set appropriately.

When patients can tolerate a deflated cuff, manage their oral secretions, protect their airway and breathe adequately through their upper airways (usually following some sort of tube occlusion trial), then they are ready to have the tube removed.

Weaning documentation

The standardised weaning and subsequent decannulation practices must be locally agreed upon and supported by multidisciplinary guidelines and documentation.

Local guidelines and practice must ensure that:

- the team taking responsibility for a patient's tracheostomy weaning review the patient regularly
- their assessment, interventions and plan are clearly documented to guide the ward MDT
- observation charts including tracheostomy and respiratory observations are accurately maintained
- the ward MDT have written guidance of how to access expert help in an emergency at any time (bedhead signs).

Summary

Table 5.8 summarises key actions related to weaning and their rationale (adapted from the NPSA expert working group).

Table 5.8 Weaning—key actions and their rationale.

Action	Rationale
Explain and discuss the procedure with the patient	To ensure consent, understanding and reduce anxiety
Have communication aids available, for example, alphabet chart, pen and paper, interpreters if necessary	To promote effective two-way communication
Sit the patient upright (unless contraindicated)	To promote chest expansion and help reduce aspiration risk
Suction the patient if necessary	To remove secretions prior to first cuff deflation
Perform the first trial cuff deflation (suctioning at the same time) and observe for signs of acute respiratory distress, desaturation or patient discomfort	To ensure timely tracheostomy wean and reduce risk of tracheal damage
Reinflate cuff if not tolerated and agree re-review date; this may be as frequently as daily	
If cuff deflation tolerated, proceed with wean to point of decannulation according to local guidelines	See Table 9
Involve MDT throughout process	See Table 5.9
Recognise signs of clinical deterioration or improvement and slow/stop/restart/speed up the weaning process as indicated	To optimise wean success and reduce patient risk
An *example* of a staged weaning approach	
Stage 1	Trial cuff deflation and speaking valve (up to 30 min)
Consider downsizing or uncuffed tube	
Stage 2	Increase speaking valve use up to 12–24 h
(Cuff may still be inflated overnight if necessary)	

Stage 3	Trial tube occlusion ‘capping off’ up to 12–24 h
Stage 4	MDT assessment and confirm decision to decannulate
Stage 5	Decannulate and assess stoma
Stage 6	Remove tracheostomy equipment after non-eventful 48-h post decannulation

Decannulation

The removal of a tracheostomy should occur as soon as there is no further need for it to remain *in situ*. The process of removing a tracheostomy tube is referred to as decannulation. It should be considered only when a patient has successfully progressed through a structured tracheostomy weaning programme. The use of standardised multidisciplinary processes will reduce the risk of complications following the removal of the tube. Prior to the removal of a tracheostomy tube, there must be multidisciplinary agreement. Occasionally, a tube must be removed in an emergency (partially displaced tube in the image). There is more detail in the emergency management section, but remember to deflate the cuff and remove any sutures prior to attempted decannulation.

The tracheostomy MDT will regularly include:

- ward nurse
- physiotherapist
- SALT
- specialist nurse (tracheostomy, ENT or outreach)
- anaesthetist or intensivist
- respiratory physician
- head and neck surgeon.

The timing of the decannulation procedure needs consideration, to minimise the risks to the patient. The clinical environment should have sufficient competent staff and equipment available. YouTube videos demonstrating safe decannulation are available here,[19] with e-learning narrated presentations available here: **videos of decannulation**.[20]

The position of the patient within the clinical setting should allow staff to visualise the patient easily and the patient should have constant access to an appropriate call system. It may be necessary to transfer the patient undergoing decannulation to an area where 1 : 1 nursing care can be offered and there is ready access to specialist staff who could appropriately deal with a failed decannulation or other complications. Decannulation should not occur late in the working day or at weekends unless adequate staff and resources are constantly available to provide advice and assessment and perform advanced airway and tracheostomy management should the procedure not be successful.

Prior to decannulation, the tracheostomy MDT will confirm:

- the patients can maintain and protect their airway spontaneously
- they are free from ventilatory support with adequate respiratory function
- they are haemodynamically stable
- they are free of fever or active infection
- the patients are consistently alert
- they have a strong consistent cough (able to cough into mouth)
- they have control of saliva +/− a competent swallow
- they are not planned for procedures requiring anaesthesia within next 7–10 days
- they are considered clinically stable.

Extra caution is essential if the patient is known to have a complex airway (e.g. requiring an adjustable flange tracheostomy), or has a previously documented difficult intubation.

Equipment

For all decannulation procedures, you will need standard bedside equipment and:

- oxygen available

- continuous oxygen saturation monitoring
- microbiological swab for stoma
- new tracheostomy tubes (for possible reinsertion)
- sterile dressing pack
- 0.9% saline
- semi-permeable occlusive dressing
- suction equipment
- relevant MDT documentation
- locally available resuscitation equipment
- access to advanced airway expert, with appropriate equipment.

Additional equipment may include:

- stitch cutter
- 10 ml syringe
- gum-elastic bougie
- bag valve mask circuit
- rebreathe circuit
- facial nebuliser circuit/adrenaline available for nebulisation.

Procedure

Decannulation is a two-person procedure. After checking all relevant equipment, the patient is placed in a comfortable position with access to the neck. A full explanation is required as this is often a time of great anxiety for the patient.

Any tapes, ties or sutures are removed while the assistant holds the tube in position. The tube will usually have had the cuff deflated for some time prior to decannulation, or be of the uncuffed type. Suction is performed and the tube is removed in expiration, to try and ensure any secretions are coughed out.

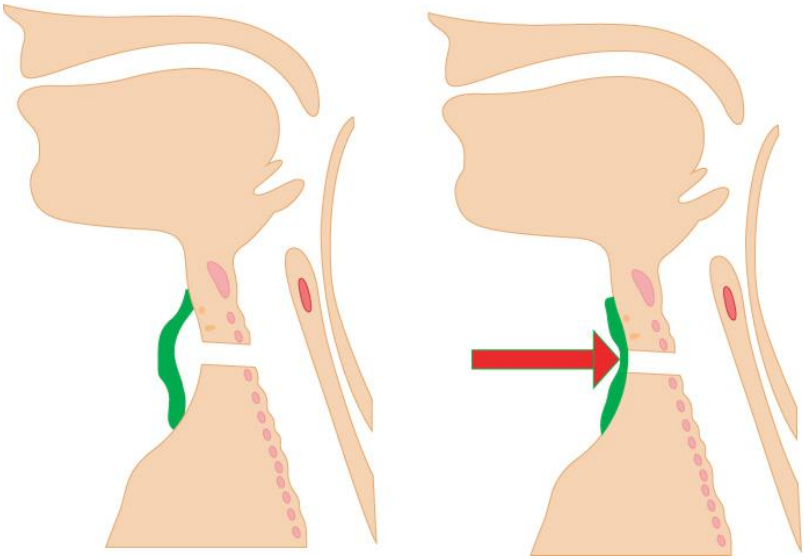
The stoma site (Figure 5.30) can be inspected, swabbed and cleaned as necessary. Most stomas will heal well, provided that the general condition and nutritional status of the patient is good, and the stoma is kept dry and infection-free. The diameter of the stoma may be expected to shrink by around 50% in the first 12 h following removal of the tube. Stomas may heal completely in as little as 3–4 days, but may also take several weeks. A small number may require formal surgical closure. Initially, the stoma is

covered with sterile gauze and an appropriate semi-permeable dressing (such as Tegaderm™ or Opsite™).

Figure 5.30 Stoma site.

On coughing and talking, it is common for the dressing to bulge outwards while the stoma remains patent (Figure 5.31). The patient can place a finger over the dressing to prevent this (Figure 5.31). The dressing is usually inspected and changed at least daily. The patient and carers must be instructed to seek appropriate attention if there is a residual leak in expiration, redness, wetness or discharge from the stoma over the days following decannulation.

Figure 5.31 The dressing can bulge on coughing or talking; this can be prevented by placing a finger over the dressing.



Documentation

Local policy and practice must ensure that:

- the team performing a decannulation document all associated events in the patient notes immediately following the procedure
- the team performing a decannulation document if they plan to re-review routinely or have discharged from caseload
- if the team performing the decannulation have discharged the patient from review, they must provide written criteria and contact details for urgent re-referral should the patient's condition deteriorate
- the level of respiratory observation required is identified
- the ward MDT have written guidance of how to access expert help in an emergency at all times
- tracheostomy emergency equipment should be left at the bedside for a further 48 h following decannulation.

Post decannulation

Following the removal of the tracheostomy tube, the patient is left with an opening into the trachea. This needs protection form entry of water or foreign bodies and needs assistance to close. An airtight dressing is required to prevent the ongoing passage of air through the tract (tracheocutaneous fistula), which will delay wound healing. Where possible, the patient should be encouraged to apply gentle pressure to the dressing while coughing or speaking. This will reduce the air pressure through the fistula to the underside of the dressing, which will loosen the dressing's contact with the skin, necessitating frequent dressing changes. The wound should be airtight within 2 weeks and if not, then a referral to the ENT team should be considered. Tissue forming along the fistula may require specialist assessment and treatment.

The use of a standardised weaning procedure should reduce the risk of patients 'failing' a decannulation attempt. However, a patient's condition can alter, which may necessitate consideration for reinsertion of the tracheostomy. The emergency tracheostomy equipment should be left at the patient's bedside for 48 h following decannulation to enable access to tracheostomy equipment for this period post decannulation. This is particularly important to maintain for those patients transferred to other clinical settings within 48 h post decannulation.

Summary

Table 5.9 summarises the key actions related to decannulation and their rationale (adapted from the NPSA expert working group).

Table 5.9 Decannulation—key actions and their rationale.

Action	Rationale
Discuss the procedure with the patient. Have communication aids available, for example, interpreters	To ensure consent, understanding and reduce anxiety
Initiate continuous oxygen saturation monitoring for procedure	To identify and alert staff to desaturation following procedure

Ensure patient sitting in an upright position	To promote chest expansion and reduce risk of aspiration
Stop any nasogastric feed or oral intake for 4 h pre-procedure Local policy may allow aspiration of nasogastric (NG) tube	To minimise the risk of aspiration and/or acute desaturation
While holding onto the tracheostomy tube, undo ties and remove all dressings in preparation for removal Ensure cuff is deflated if present	To prepare tube for removal
Remove the tracheostomy on maximal inspiration, or as per local policy	To minimise the risk of alveolar collapse
Prior to dressing application: check for signs of respiratory distress and confirm patient can voice/ cough while stoma occluded	To monitor for complications to tube removal prior to dressing application
Using a sterile technique, clean the stoma site with saline and dress site with a semi-permeable occlusive dressing	To reduce the risk of infection and optimise wound healing
Ensure close observation of patient's respiratory status post procedure as per local guidelines	To reduce patient risk
Update MDT post procedure and clarify further monitoring requirements, dressing needs and alert to possible complications	To optimise team communication and safe patient rehabilitation
Redress site at least every 24 h. Measurements of the closing fistula may assist with objective assessment of a slow healing wound	To monitor for appropriate wound closure (estimated at 7–14 days)

Bedside equipment

Emergency equipment

Any clinical area caring for patients with a tracheostomy must have emergency equipment immediately available. Some of this will be at the

patient's bedside as it is required for routine care, while other equipment is provided in the ward or nursing area.

If a patient is transferred to a different location within a hospital, then the accompanying staff must ensure that any equipment that may be required in an emergency is available at the destination, and also en route. There have been many incidents recorded in hospital lifts, corridors and remote departments, where a blocked or displaced tube could not be managed because of a lack of immediately available equipment.

Equipment may be in the form of a dedicated case or box that accompanies the patient, or stocked on a difficult airway trolley in a critical care area. This equipment, including suction, should accompany patients wherever they go during their hospital stay. An appropriately trained carer who is competent to use the equipment in an emergency must also accompany them.

Emergency equipment available in a ward or clinical area

This includes:

- basic airway equipment—oxygen masks, self-inflating bags, oral and nasal airways
- advanced airway equipment—laryngeal mask airways and laryngoscopes with appropriate tubes (arrest trolley or similar)
- capnography[21]
- a fibreoptic scope
- tracheal dilators[22]
- bougies

Equipment for routine care kept at the bedside

- Humidification equipment
- Suction with selection of appropriate suction catheters
- Spare tracheostomy tubes
  - One the same size
  - The other tube one size smaller
- Clean pot for spare inner cannula

- Sterile water for cleaning the suction tube
- Scissors (and stitch cutter if tracheostomy tube is sutured)
- Water-soluble lubricating jelly
- Sterile dressing pack
- Tracheostomy dressings
- Tracheostomy tapes
- Personal protective equipment (gloves, aprons, eye protection)
- Sterile gloves for performing deep suction
- Nurse call bell: the patient may be unable to verbally call for help
- Communication aids: the patient may not be able to verbalise
- Bedside equipment checklist.

It is important to check that all equipment is available at the beginning of every shift. A suitable container or carrier box is useful to keep all of this equipment together. TRACHI-CASE™ is one of a number of commercially available kits for this purpose (Figure 5.32). These types of cases can then accompany the patients if they need to be transferred to a different location. Remember that you will need portable suction and a portable oxygen supply to accompany the patients.

Figure 5.32 A TRACHI-CASE™ kit.

The case should contain:

- spare trachy tubes
- suction catheters
- scissors
- stitch cutter
- lubricating jelly
- tapes
- dilators (local choice).

Dedicated clinical areas

One of the recommendations to come from the work looking at patent safety incidents is to cohort patients together to concentrate staff, skills, equipment and expertise. This should make equipping and training locations that will be designated to care for tracheostomy patients easier.

This approach does mean that the majority of clinical locations will lose expertise of looking after neck-breathing patients, which may restrict bed movements in an acute hospital. However, the risks of caring for this cohort in clinical areas without the necessary equipment, training and experience place the patient at an increased risk of airway complications, morbidity and mortality. One of the key recurring themes in the published critical incident reviews was a lack of equipment and training by staff, meaning that routine care was not provided, warning signs and red flags were missed and that emergencies were not managed effectively. Concentrating training, equipment and expertise would be expected to reduce these incidents.

Dedicated tracheostomy teams and tracheostomy ward rounds are additional well-published approaches to reducing tracheostomy-related critical incidents. The choice of approach adopted will be determined locally.

Humidification and speech after laryngectomy

Following total laryngectomy, the normal warming and humidification that is provided by the native upper airways is lost as inspired and expired air flows directly through the laryngectomy stoma on the front of the neck, bypassing the nose and mouth (Figure 5.33).

Figure 5.33 Stoma covers *in situ*.

Patients will therefore need an alternative method of ensuring that the gas inhaled into the lungs is humidified. This can be provided by applying specific covers to the stoma that contain hygroscopic material (like in HME filters), which can capture moisture and, to some degree, heat. Most patients will be self-caring shortly after their initial procedure and will be able to apply, remove and care for any bespoke stoma covers themselves. The covers do add a degree of resistance to respiration, which may become clinically relevant if the patient develops an acute infection or the covers become blocked with purulent secretions. Any stoma covers should be removed in an emergency for this reason.

A Buchanan bib or similar device is another way of humidifying inhaled gases and is preferred by some patients. These can be used by tracheostomy or laryngectomy patients and come in a variety of styles and

designs. Some can disguise the stoma completely and the patient just appears to be wearing a scarf or cravat (Figure 5.34).

Figure 5.34 Buchanan bib and cravat style humidification devices.

Speech after total laryngectomy

Surgical removal of the vocal cords results in an inability to phonate. This can be a source of immense frustration for patients. There are a variety of options available to total laryngectomees and these will be considered in turn.

Electrolarynx

These devices vibrate the external skin of the neck. They are used in combination with altering the shape of the mouth to create artificial speech. A degree of training is usually required (Figure 5.35).

Figure 5.35 An electrolarynx.

Oesophageal speech

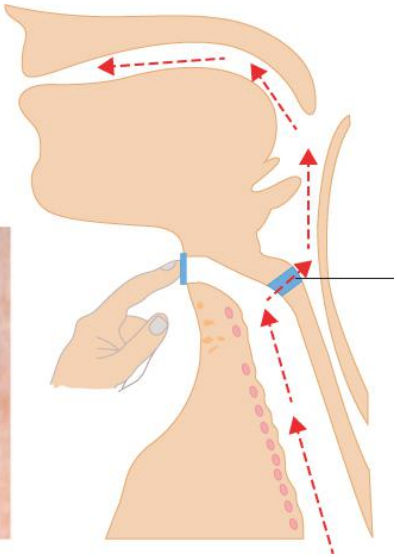
This type of speech involves swallowing air into the gullet via the mouth/nose and then 'burping' it back into the pharynx. This can be coupled with mouth shaping to generate speech. Some patients are very good at this, but again, this technique requires practice.

Tracheo-Oesophageal Punctures

These devices are often known as TEP (from the US spelling of 'esophagus'). They can be created at the time of primary surgery, or later. A puncture is made into the posterior portion of the trachea into the oesophagus behind. Exhaled air can be forced through this connection by the patient by covering their stoma in expiration. Air passes through the pharynx as mentioned and oesophageal speech is possible. A one-way valve is usually placed into the puncture site to reduce the risk of contamination of the airways with GI contents. Some stoma covers incorporate an additional valve to direct air through the TEP valve without manual occlusion of the stoma, which makes hands-free speech possible. TEP valves *should not be removed* in an emergency as they should not occlude the airway and removing them will not improve acute respiratory problems (Figure 5.36).

Figure 5.36 TEP valve visible through the laryngectomy stoma, between the posterior wall of the trachea and the oesophagus behind.

Reproduced with permission of HEE eLfH.



Patient information sheets examples

There is a selection of information sheets for patients, carers and staff developed by the National Association of Laryngectomee Clubs in the UK. Their resources can be found at www.laryngectomy.org.uk, examples of which are shown below.

[1] http://www.youtube.com/watch?v=wlwl1r5UuMw

[2] http://youtu.be/rXW2MPSxFrU

[3] http://www.youtube.com/watch?v=h2isSvHCyi8

[4] http://youtu.be/rXW2MPSxFrU

[5] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Dressings and Ties.htm

[6] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Dressings and Ties.htm

[7] http://www.youtube.com/watch?v=VPYiksEt-qA

[8] http://www.tracheostomy.org.uk/Multimedia/Changing Trachy Tube/Changing a trachy tube.htm

[9] http://www.tracheostomy.org.uk/Multimedia/Changing Trachy Tube/Changing a trachy tube.htm

[10] http://www.youtube.com/watch?v=tt7U86YvkDo

[11] http://www.youtube.com/watch?v=ZXS-mfEjxHc

[12] http://www.youtube.com/watch?v=RPhCCGsXBHU

[13] http://www.youtube.com/watch?v=Yv6hsCOd7vU

[14] These options are more likely to result in incorrect placement of the tube tip and should only be considered in an emergency.

[15] http://www.youtube.com/watch?v=1PxEam4CBUE

[16] Under specialist supervision, it is possible to decannulate some patients who will need ongoing non-invasive respiratory support via a face or nasal mask.

[17] http://www.youtube.com/watch?v=zEenPuiIc_Q

[18] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Speaking Valve.htm

[19] http://www.youtube.com/watch?v=tt7U86YvkDo

[20] http://www.tracheostomy.org.uk/Multimedia/Explaining the algorithm/AlogrithmExplained2.htm

[21] Waveform capnography and a fibreoptic scope (suitable for immediate use) should be *available* for all patients with a tracheostomy. In critical care, specialist ward areas and areas that look after a high volume of tracheostomy patients, these should be *immediately* available. For other ward areas, availability should be within minutes (e.g. on a cardiac arrest trolley). This should ideally be portable and able to be used quickly without a light source and separate 'stack' system. All staff caring for

tracheostomy patients and those who respond to emergencies should know how to access and operate these devices around the clock.

[22] There is conflicting opinion on whether tracheal dilators are useful in an emergency. This should be agreed locally; influences include patient demographics, types of tracheostomy performed and clinician preference.

Chapter 6

Complications

Complications associated with a tracheostomy

Complications can be divided into those associated with insertion of the tracheostomy (surgical or percutaneous), those that arise following the procedure (usually blocked or displaced tracheostomy tubes) or as later complications. These can be serious and sometimes fatal. The following list shows how these complications are usually grouped.

Immediate complications (peri-operative period)

- Haemorrhage (usually minor, can be severe if thyroid or blood vessels damaged)
- Misplacement of tube—within tissues around trachea or to main bronchus
- Pneumothorax
- Tube occlusion
- Surgical emphysema
- Loss of the upper airway.

Delayed complications (post-operative period <7 days)

- Tube blockage with secretions or blood—may be sudden or gradual
- Partial or complete tube displacement
- Infection of the stoma site
- Infection of the bronchial tree (pneumonia)

- Ulceration and/or necrosis of trachea
- Mucosal ulceration by tube migration (because of loose tapes or patient intervention)
- Risk of occlusion of the tracheostomy tube in obese or fatigued patients who have difficulty extending their neck
- Tracheo-oesophageal fistula formation
- Haemorrhage (local tissue trauma or erosion through blood vessels).

Late complications (late post-operative period >7 days)

- Granulomata of the trachea may cause respiratory difficulty when the tracheostomy tube is removed
- Tracheal dilation, stenosis, persistent sinus or collapse (tracheomalacia)
- Scar formation—requiring revision
- Blocked tubes may occur at any time, especially if secretions become thick, the secretions are not managed appropriately (suction) and humidification is not used
- Haemorrhage.

Potential problems post-placement

Blocked tracheostomy

One role of the upper airway is to moisten and warm inhaled air before it reaches the lungs. Cilia are small hair-like protrusions that line the respiratory tract. Their function is to prevent infection within the respiratory tract, by moving mucus and other particles away from the lungs. Inserting a tracheostomy tube bypasses these natural mechanisms, which means the lungs will receive cool, dry air. Dry air entering the lungs may reduce the motility of the secretions within the lungs and the function of the cilia. In addition, the patient may not be able to cough and/or clear the secretions from the airways through the tracheostomy. This may cause the tracheostomy to become blocked by these thick or dry

secretions. Blocked tracheostomy tubes can be minimised by careful humidification, tracheal suction and inner tube care. However, it is necessary to keep emergency equipment at hand at all times, as a blocked tube may lead to respiratory arrest.

Pneumonia

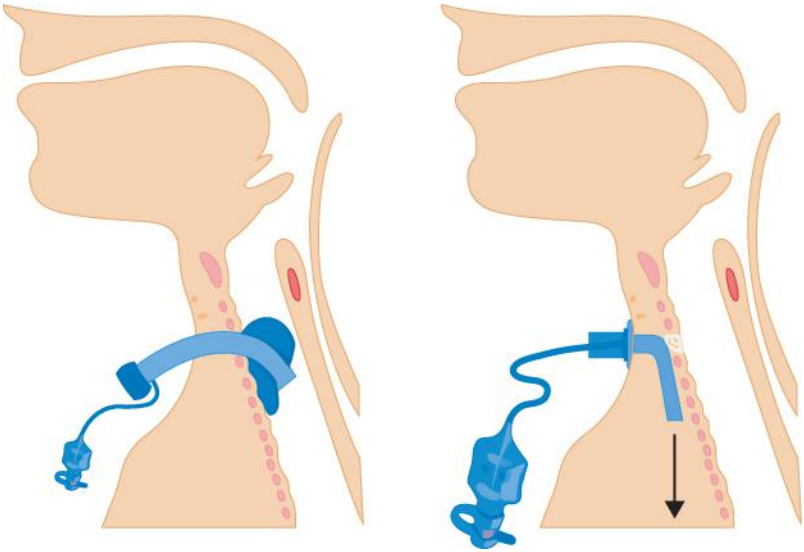
A build-up of secretions may lead to consolidation and even collapse of some areas of the lung, and thus contribute to pneumonia. The presence of a foreign body in the airway will hamper normal physiological defence mechanisms and particulate matter, oral secretions, gastric contents and bacteria can be aspirated past any cuff into the airway. These risks can be minimised by careful humidification, tracheal suction and inner tube care, and may be helped by suctioning above the cuff with specific sub-glottic suction tubes. Aspiration of gastric contents may also lead to pneumonia. This can occur with patients who are unable to swallow safely. Any patient who you suspect may have aspirated will need to have a formal swallowing assessment.

Displaced tracheostomy tube

The tracheostomy tube can become partially or completely displaced. The tube may migrate out of the stoma, or into the soft tissue of the neck. The tube may become displaced by coughing, because of its weight or the weight of attached breathing circuits, or by patient interference. Partial tube displacement is more dangerous, as it is not always visibly obvious that there is a problem with the tube (Figure 6.1). In order to keep tracheostomy tubes in position they must be secured carefully and monitored. Any concerns raised by the patient or nursing staff must be promptly investigated.

Figure 6.1 Tubes can become displaced.

Reproduced with permission of HEE eLfH.



Haemorrhage

It is common for some bleeding to occur after a tracheostomy has been performed. This usually settles within a few days. Bleeding can occasionally be significant or even catastrophic. Bleeding can be from the trachea, stoma or surrounding tissues and can be because of direct trauma of the tissues, puncture or injury to adjacent blood vessels, or the tube or cuff eroding into surrounding tissues or vessels over time. Bleeding can also come from the lungs themselves and become evident through tracheal suction. These problems are compounded in a patient with a coagulopathy.

A trachea-innominate fistula can occur if the tube erodes into the innominate artery. This is a rare complication, but is associated with lower placement of the tube in the trachea. The hallmark is a warning or 'sentinel' bleed. Any haemorrhage should prompt a fibreoptic inspection of the trachea. If an arterial bleed is suspected, fibreoptic inspection should occur immediately with an experienced surgeon and resuscitation measures available. Arterial haemorrhage can become rapidly fatal. Hyperinflation of the tracheostomy tube cuff or an endotracheal tube cuff may help to tamponade the bleeding point, prior to definitive surgical management.

Tracheostomy Red Flags

Most healthcare workers will be familiar with the descriptions of critical incidents that developed where warning signs were often present and sometimes recorded, without their significance being recognised. Tracheostomy red flags may be clues that a problem has, or is about to occur and need to be acted upon. Prompt assessment by someone competent to do so is required and a fibreoptic inspect of the position of the tracheostomy tube to confirm correct placement within the trachea is usually indicated. All staff caring for patients with a tracheostomy should be familiar with these warning signs. Emergency management is discussed in Chapter 7.

Given here is a list of the red flags.

Airway

- The patient with a cuffed tracheostomy tube suddenly being able to talk (implying gas escaping proximally and the cuff no longer 'sealing' the trachea)
- Frequent requirement for (excessive) inflation of the cuff to prevent air leak
- Pain at the tracheostomy site
- A suction catheter not passing easily into the trachea
- A changing, inadequate or absent capnograph trace.

Breathing

- Increasing ventilator support or increasing oxygen requirements
- Respiratory distress
- Surgical (subcutaneous) emphysema (gas in the soft tissues)
- The patients complaining that they cannot breathe or have difficulties in breathing
- Suspicion of aspiration (feed aspirated on tracheal toilet—suggests that the cuff is not functioning adequately).

Circulation or any other general clinical deterioration

- As with all assessments of the acutely unwell patient, an ABCDE assessment includes ensuring that the airway is patent; in this case, this includes assessment of the tracheostomy tube.

Local infection

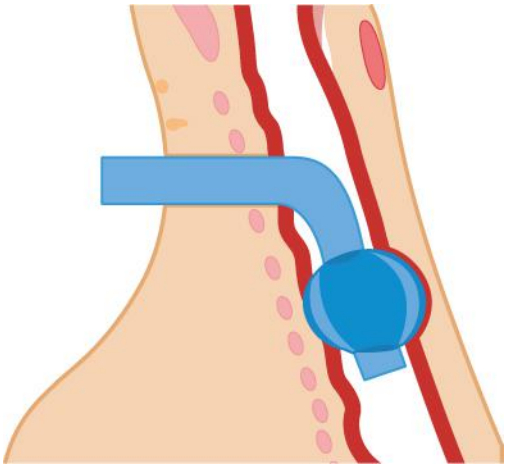
The stoma is an open surgical wound and there is always a risk of site infection, with the ever-present threat of introducing organisms from the sputum. A stoma should be treated as a surgical wound and cared for appropriately. Careful observation and keeping the wound clean and dry with regular dressing changes will help reduce the incidence of infection. Prompt swabbing and appropriate topical and systemic antimicrobial treatment will help minimise the impact of local infection. As the stoma is an open wound opening directly into the respiratory tract, there is potential for the lower respiratory tract to become infected. Poor suction techniques may also increase the incidence of infection.

Tracheal damage/ischaemia

Damage to the trachea may be caused by the pressure of the inflated cuff pressing on the mucosa of the trachea. The capillary pressure in the tracheal mucosa is around 20 cm H_2O and consistent cuff pressure above this limit will risk ischaemic damage to the trachea. This situation may be made worse by critical illness and hypotension, which will reduce the capillary perfusion pressure. Direct mucosal damage can also occur by poor tracheal suctioning techniques, ill-fitting tubes or excessive movement of the tube within the trachea (Figure 6.2). Modern tracheostomy tubes have low-pressure cuffs that extend over a greater surface area; however over-inflation should still be avoided. The pressure in the cuff should be just adequate to prevent air leakage and seal the airway against aspiration.

Figure 6.2 Cuff hyperinflation resulting in direct mucosal damage.

Reproduced with permission of HEE eLfH.



Altered body image

This is an important factor as it can have a major psychological impact. If possible, the patient should have careful pre-operative explanation. If this is not possible, the patient must receive explanation and support post-operatively. The patient should know that scarring would usually be minimal when the tracheostomy is removed and the stoma has healed. One of the most frustrating aspects for patients, especially those waking from an induced coma, is that they are unable to speak when the tracheostomy tube cuff is inflated. As soon as possible, the patient should be reassured that speech will return. Most stomas will heal well provided that the general condition and nutritional status of the patient is good, and the stoma is kept dry and infection-free. The diameter of the stoma may be expected to shrink by around 50% in the first 12 h following removal of the tube. Stomas may heal completely in as little as 3–4 days, but may also take several weeks. On average, the stoma will close and heal within 4–6 weeks.

Communication

Patients with a cuffed tracheostomy will be unable to speak; loss of speech while the tracheostomy is in place could cause great distress to the patient,

even if warned beforehand. This can cause fear because of inability to attract attention or anxiety on being unable to communicate (even with the cuff down). Generally, patients who have an uncuffed tube or the cuff deflated will be able to speak with a speaking valve in place. Communication aids, such as pen/paper or picture cards, are vital to prevent the patient feeling frightened and isolated. In addition, ensure the patient has a nurse call bell at all times.

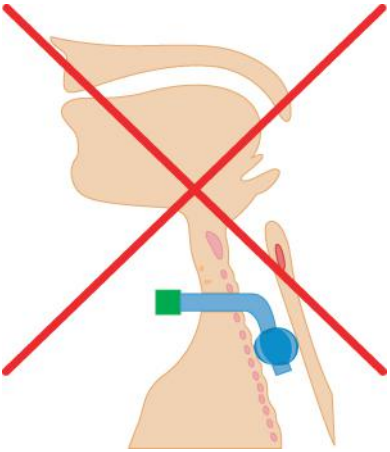
Speaking valves

These are one-way valves that fit over the end of the tracheostomy tube. They allow the patient to breathe in through the tracheostomy, but not out. The airflow has to go up through the larynx and out of the mouth. This can allow the patient to talk, but can be tiring for the patient because of increased resistance to airflow. An animated presentation showing airflow when speaking valves are used can be viewed in the footnote.[1] Because air cannot flow out through the tracheostomy, these valves can be extremely dangerous. Speaking valves should ideally only be used with an uncuffed and fenestrated tube and only when the fenestrated inner cannula is in place. It is possible to use them with a non-fenestrated or even cuffed tube, providing that the cuff is deflated. A speaking valve used with a standard tube with the cuff deflated is potentially hazardous, and should only be used by staff with the experience and the necessary infrastructure to recognise and immediately manage any resulting complications (Figures 6.3 and 6.4).

Figure 6.3 Green speaking valve in situ attached to a cuffed tracheostomy tube (cuff deflated) Reproduced with permission of HEE eLfH.

Figure 6.4 Speaking valves should never be used with the cuff inflated.

Reproduced with permission of HEE eLfH.



[1] http://www.tracheostomy.org.uk/Multimedia/Nursing Care of Trachy/Nursing Care of Trachy Speaking Valve.htm

Chapter 7

Red flags

Like most critical incidents, warning signs often precede tracheostomy-related clinical problems. Because these signs are sometimes only apparent with hindsight, it is essential that you know what to look out for, so that you can troubleshoot at an early stage and stop minor problems escalating. Tracheostomy-related clinical problems are called 'tracheostomy red flags', although some are applicable to laryngectomy patients too.

It is easy to develop a false sense of security when a patient has a tracheostomy tube *in situ*. Remember though that this is an artificial airway, just like an endotracheal tube. Problems that arise are therefore airway problems and can develop quickly and dramatically into life-threatening situations, especially if the patient is ventilator-dependent or critically ill. Think about a patient in the ICU or in the operating theatre with a large air leak from an endotracheal tube – everyone would agree that this needs to be attended to as a matter of urgency. This is the same for a tracheostomy tube.

What should you do if you detect a red flag?

A prompt assessment of the tracheostomy and the patient should be made by someone who is competent to do so. Who this is depends on how the patient is, your role and where you work, but the person making the assessment must to be able to work out what the problem is and address it. Interventions could range from a simple reassuring assessment, a fibreoptic inspection of the tube or airways or replacement of the tracheostomy tube.

Like any assessment of the unwell patient, this should always start with 'A for airway'. In the case of a patient with a tracheostomy, there *may* be two airways to consider, or with a laryngectomy, only one (in the front of the

neck, not the face). Any airway problem can cause the patient to become unwell and show signs of distress. Conversely, patients with tracheostomies can become unwell with all the problems that other patients get too. It is easy to become fixated with the tracheostomy.

The 'flags' can be divided up into different categories.

- Airway flags
- Breathing flags
- Specific tracheostomy flags
- General flags.

Airway flags

If the patient has a cuffed tracheostomy correctly sited in the trachea, no gas should escape through the mouth. If the patient is talking to you, or audible air leaks or bubbles of saliva are seen or heard at the mouth or nose, then gas is escaping past the cuff. This may imply that the cuff is damaged or the tube tip is not correctly sited. Grunting, snoring or stridor are also signs that there is an airway problem.

Breathing flags

Listening to the patient, or observing the patient or instrumentation may show that the patient:

- is not breathing (apnoea), which is detected by capnography or clinically
- has difficulty in breathing (or with ventilation), which may be reported by the patient or observed clinically:
  - accessory muscle use
  - increased respiratory rate
  - higher airway pressures
  - lower tidal volumes
- has hypoxia
- is making whistling noises or has noisy breathing.

Specific tracheostomy flags

Careful observation may show that the patient:

- has a visibly displaced tracheostomy tube (Figure 7.1); if this is an adjustable flange tube, check to see where it was last positioned
- has blood or blood-stained secretions around the tube – a recently performed or changed tracheostomy bleeds a little, but if in doubt, it should be assessed
- reports increased discomfort or pain
- requires a great deal of air to keep the cuff inflated, which may be because:
  - the cuff is damaged or has an air leak (in which case, it needs to be replaced)
  - has a displaced tube and the cuff needs hyper-inflation to keep it 'sealed'.

Figure 7.1 This tracheostomy tube has become displaced.

General flags

Any physiological changes can be because of an airway problem. Specifically, changes in:

- respiratory rate
- heart rate
- blood pressure
- level of consciousness.

Anxiety, restlessness, agitation and confusion may also be because of an airway problem.

Chapter 8

Emergency management of the patient with a tracheostomy or laryngectomy

The management of tracheostomy-related emergencies has developed in a somewhat piecemeal manner, in a way similar to that of general airway emergencies before publication of the difficult airway algorithms. Before such guidance, emergencies were commonly managed by relying on individually acquired skills and experience, or lessons learned from previous errors. The NTSP were involved in analysing critical incidents reported to the UK National Patient Safety Agency and recurrent themes were identified, evident in similar analyses.

It was clear that simple, authoritative guidelines were urgently required, similar in structure to previous difficult airway algorithms and Resuscitation Council (UK) Advanced Life Support (ALS) guidelines. Our tracheostomy and laryngectomy emergency guidelines were developed following wide consultation with key national bodies involved in tracheostomy care, incorporating feedback from their members and utilising case reports in the literature. This chapter presents the guidelines and discusses their rationale. A similar, detailed explanation has been published in the journal *Anaesthesia* in 2012, upon which this section is based. The full text of this article is available via this link[1] (McGrath et al., 2012):

Guideline development

Draft guidelines were developed, tested and refined locally before being re-submitted to the UK stakeholder organisations. Extensive use was made of real-life critical incidents that were recreated using high-fidelity simulation and different management strategies were attempted with different staff members and local airway experts. Near-final guidelines were subject to open peer review for a period of 6 months via the NTSP and UK stakeholder organisation websites. During this period, the resources were accessed over 28 000 times and the emergency algorithms downloaded nearly 9000 times, with worldwide feedback received.

Generally, feedback was positive and supportive of the project aims, with many comments adapted to be included in the final version of the guidelines with the contributors' permission.

First, it was clear from initial analyses that distinct bedside information and algorithms were required for patients with a potentially patent upper airway and those with a laryngectomy. This led to the development of the bedhead signs, allowing essential information to be clearly displayed and immediately available to responders in an emergency. This allows the responder to know immediately whether the patient has any special considerations for managing the upper airway or the tracheostomy stoma. Bedside information can also summarise key details regarding the nature and date of the tracheostomy, the method of stoma formation and the function of any 'stay sutures'.

Second, it was recognised that separate algorithms were needed for patients with a potentially patent upper airway and those with a laryngectomy. However, it was also apparent that there would be similarities between the algorithms, with the management of laryngectomy patients following the same steps as for tracheostomy patients, but without the upper airway elements.

It was clear to us that a number of principles should underpin the guidelines that we developed. The two key priorities were supported by our critical incident reviews: oxygenation of the patient takes priority (not necessarily securing the airway immediately and definitively, unless required for oxygenation) and the best assistance should be sought early. Ideally, this assistance would include other members of the multi-disciplinary team who are trained and competent to deal with tracheostomy emergencies. Emergencies should be managed in adequately equipped clinical environments.

Rather than taking a problem-specific approach, we developed a generic algorithm that would cover the vast majority of common and easily reversible clinical situations that arise, while accepting that a number of special circumstances do exist (e.g. the critically ill ventilated patient in the ICU, or the patient who has undergone a complex tracheal reconstruction). Even in these complicated scenarios, key airway management principles can still be followed. This approach also allows training to be standardised.

We have divided the competencies and training required between those of the primary and secondary responders. The primary responder (typically a nurse, junior doctor or allied health professional) needs to be guided to detect airway problems, to assess tracheostomy and airway patency and to provide basic emergency oxygenation. The secondary responder (typically an anaesthetist, intensivist, head and neck surgeon or specialist practitioner) will have skills in conventional airway management and will also be guided to use skills in managing the tracheostomy or stoma. These skills would typically include oro-nasal intubation techniques (including difficult intubations), the ability to use a fibreoptic scope to assess or replace tracheostomy tubes and the ability to perform and manage an emergency surgical airway or tracheostomy. Our emergency algorithms are thus divided into sections to reflect the differing skills of the responders.

The algorithms are applicable for any urgent or emergency situation that develops in a patient with a tracheostomy or laryngectomy.

Interactive algorithms with video links to each of the key steps are available from the website www.tracheostomy.org.uk. There are details of each of the key steps in the algorithm explained in the e-learning resources associated with this manual.

Patent upper airway: the 'Green algorithm'

This algorithm is paired with the green bedhead sign and assumes a *potentially patent* upper airway, meaning that it is anatomically possible for the upper airway to connect to the trachea and thus theoretically allow ventilation by this route. This is in contrast to the situation with a laryngectomy. The following section should be viewed in conjunction with the green algorithm. It is important to remember that the original reason for the tracheostomy may have been a difficult, or even impossible, upper airway.

Help and equipment

The first step is to call for help. Who is called will depend on the patient, the responder and the location. The bedhead sign should display local details specific to this patient of who to call and how to avoid delays. The details of the bedhead signs should be agreed and completed when the patient is first admitted or transferred to the clinical area, not when an emergency occurs. If out-of-hours specialist or clinical cover is not immediately available, appropriate arrangements must be in place to ensure that assessments and emergency responses can be delivered. Clinical areas caring for patients with tracheostomies should be staffed and equipped to do so. This includes the provision of routine and emergency airway equipment. Most equipment should be at the bedside. Additional equipment and fibreoptic scopes should be available at all sites (including wards) where patients with a tracheostomy are cared for. Fibreoptic scopes are used either to enable inspection of the tube position, to assist in the replacement of the tube or to enable management of the upper airway. Specialist areas such as critical care will need a difficult intubation trolley, waveform capnography and a fibreoptic scope to be immediately available.

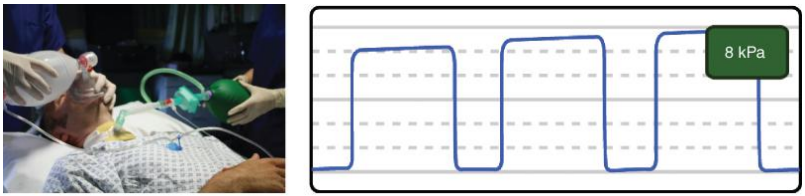
Assessment of breathing

Following the principles of basic life support, the first clinical steps attempt to open the airway and look for evidence of breathing. Tracheostomy patients will *usually* have two airways (the native upper airway and the tracheostomy) and clinical assessment takes place by looking, listening and feeling at the face *and* tracheostomy tube or stoma for 10 s, following basic upper airway opening manoeuvres. Videos of this can be seen here.[2]

A Mapleson C anaesthetic breathing system (commonly referred to as a 'Waters circuit', Figure 8.1) can be used attached to a facemask placed over the face or tracheostomy stoma, or directly to the tracheostomy tube. The collapsible bag can offer visual clues to confirm the presence of respiration if the bag is seen to move. This circuit also enables ventilation, but must be used only by those who are competent to do so, as harm may

occur if the expiratory valve is left closed. Videos detailing this assessment may be viewed here.[3]

Figure 8.1 (a) A Mapleson C ('Waters circuit') anaesthetic breathing system. (b) Waveform capnography is invaluable when managing airways.



(a) (b)

Waveform capnography is invaluable when managing airways and should be used at the beginning of the assessment. If the patient is breathing spontaneously, apply high-flow oxygen to the face *and* tracheostomy. This will require two oxygen supplies, which may necessitate the use of the oxygen cylinder on the resuscitation trolley. Pulse oximetry can add valuable information as to the success of interventions and to the urgency of subsequent interventions.

If the patient is not breathing (apnoea or occasional gasps) or there are no signs of life, then a pulse check must occur and cardiopulmonary resuscitation commenced as per international guidelines. The remaining details of these algorithms deal with managing the airway – a critical component of any ALS teaching. A primary tracheostomy problem (e.g. tracheostomy tube blockage) may have led to the cardio-respiratory arrest in the first instance.

Assessment of tracheostomy patency

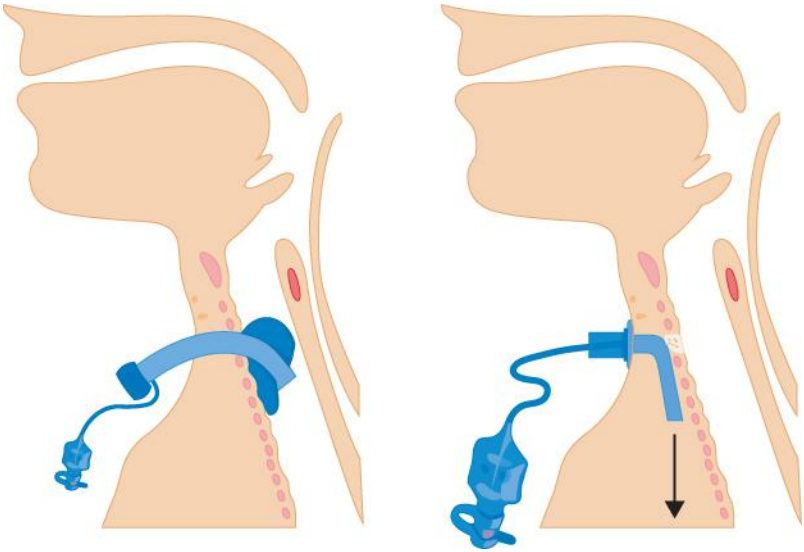
Simple, easily reversible problems have caused significant morbidity and mortality to tracheostomy patients. These have included the inappropriate use of obstructing (decannulation) caps or obturators attached to the tracheostomy tubes, incorrectly used speaking valves (with an inflated, cuffed tube) and humidifying devices (e.g. Swedish noses) blocked with secretions. Because of this, any device attached to a tracheostomy tube must be removed in an emergency.

Inner tubes used with tracheostomies can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly in their design, with some requiring replacing after cleaning, to allow connection to breathing circuits. It is essential to know what equipment is used in your clinical areas, as unfamiliarity with equipment may lead to morbidity and mortality.

Passing a suction catheter via the tracheostomy will establish whether the tube is patent and also allow therapeutic suction to be performed (Figure 8.2). The suction catheter needs to pass easily beyond the tracheostomy tube tip and into the trachea. The depth of insertion will depend on the length of the tube *in situ*. Gum-elastic bougies or similar introducers should be avoided at this stage, because these stiffer devices are more likely to create a false passage if the tracheal tube tip is partially displaced. The soft suction catheters will not advance sufficiently into the pre-tracheal tissues and are less likely to cause further problems if used to assess patency (Figure 8.3).

Figure 8.2 Suctioning via the tracheostomy.

Figure 8.3 A soft suction catheter will not pass if the tracheostomy tube has become displaced.



A distinction is made between using hand ventilation (by attaching an anaesthetic breathing circuit to the tracheostomy tube) for *resuscitation*, versus its use for *diagnosing* airway patency. There have been several incidents, including deaths, where vigorous attempts at ventilation via a displaced tracheostomy tube have caused significant surgical emphysema, making access to the neck increasingly difficult. This can be made worse if a fenestrated tube becomes partially displaced. Therefore, this guidance only recommends the use of gentle hand ventilation if required, and only *after* the tracheostomy has been confirmed to be patent using a suction catheter.

If the suction catheter passes easily into the trachea, then the tracheostomy tube can be regarded as at least partially patent. The 'ABCDE' assessment can continue as per standard guidelines. If the patient is not breathing, effective ventilation via the tracheostomy will require an inflated cuff (with an unfenestrated inner tube if necessary) to seal the trachea and allow positive pressure to be delivered to the lungs.

If the suction catheter will not pass, it is reasonable to conclude that the tube is blocked or displaced. At this stage we are moving to salvage the situation, and deflating the distal cuff, if present, may allow airflow past a partially displaced tracheostomy tube to the upper airways. In the special

circumstance of early post-procedural haemorrhage (complicating up to 5% of new tracheostomies), leaving the cuff inflated may cause a tamponading effect, as discussed in the complications section (Chapter 6). Reassessment of both the tracheostomy and the upper airways will determine if the airway(s) was now patent. If cuff deflation improves the clinical condition, the responder can continue the 'ABCDE' assessment and await experienced assistance. The goal is adequate oxygenation and although the tracheostomy tube may still be (partially) occluded or displaced, there may be sufficient air entry to ensure some clinical stability while awaiting expert assistance.

Removal of the tracheostomy tube

If a suction catheter cannot be passed and deflating the cuff fails to improve the clinical condition, the tracheostomy tube is likely completely blocked or displaced, and the patient cannot breathe around the tube adequately. Continued attempts at 'rescue' ventilation via the upper airways or the tracheostomy tube will not be effective as the airway is obstructed. The tracheostomy tube should be removed at this point. There may be concerns about the consequences of removing a tracheostomy tube from a patient with a difficult or obstructed upper airway, or one whose tracheostomy is known to be difficult. However, when faced with a deteriorating patient with an obstructed airway, a non-functioning tracheostomy offers no benefit, with considerable potential for harm. Following tracheostomy tube removal, reassessment at both airways (mouth and trachea) is required, ensuring oxygen is reapplied to face and stoma, to maximise the chances of oxygenation. This may resolve the immediate airway problem and if the patient is breathing and improving, ABCDE assessment continues.

It is important to note that definitive management of the airway (reinsertion of a tracheostomy or oral tube) is not necessarily required immediately if the patient is not hypoxic. Insertion of a new tracheostomy tube or endotracheal tube is likely to require expertise and equipment, and harm has resulted from inappropriate attempts to manipulate the stoma blindly when this is not immediately required.

The special circumstance of a known difficult or obstructed upper airway, or previously difficult-to-insert tracheostomy, may necessitate a fibreoptic

inspection of the tube while it remains *in situ*, in preference to its prompt removal (Figure 8.4). This is only relevant where appropriate equipment and expertise are *immediately available* and the patient is clinically stable enough to tolerate the procedure. Waiting for equipment or performing unsuccessful fibreoptic examination should not delay the removal of a blocked or a displaced tube when faced with a deteriorating patient.

Figure 8.4 Fibreoptic inspection of the *in situ* tube.

Emergency oxygenation

If the patient fails to improve after removing the tracheostomy tube, *primary emergency oxygenation* may be achieved by the oro-nasal route, the tracheostomy stoma or by both routes. The choice of route will depend on the responder's experience. If attempting to ventilate via the upper airways, remember to occlude the tracheal stoma to maximise the possibility of effective ventilation (Figure 8.5). Ventilation can also be achieved directly via the tracheostomy stoma. A small, paediatric facemask or a laryngeal mask can be applied to the skin of the anterior neck (Figure 8.6). In order to achieve effective ventilation, occlusion of the upper airway by closing the nose and mouth may be required, especially if there is a large leak. Two airway teams may attempt to oxygenate the patient simultaneously if ventilation proves difficult (Figures 8.6 and 8.7). The goal remains oxygenation, and formal insertion of an airway device may not be required – a situation analogous to prioritising oxygenation, and not intubation, in every cardiac arrest patient.

Figure 8.5 When attempting to ventilate via the upper airways, occlude the tracheostomy stoma.

Figure 8.6 Ventilation can be achieved through the tracheostomy stoma via a paediatric facemask or LMA (shown here) applied to the skin.

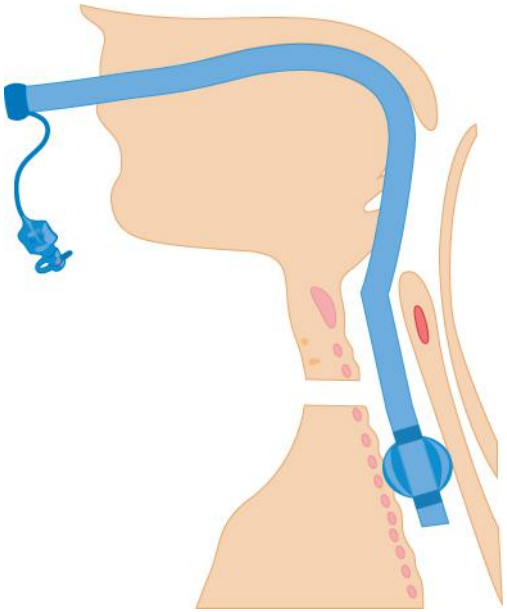
Figure 8.7 Two airway teams may be required.

If effective oxygenation or ventilation cannot be achieved, *secondary emergency oxygenation* manoeuvres are required. These are advanced techniques and the choice will depend on the patient, the responders and the equipment available. These are likely to be dire clinical situations and

separate airway teams may be appropriate – one working at the head/face and one working on the neck (Figure 8.7). Oral intubation may be possible, and if so, a long (i.e. uncut) tube can be used. This tube may be advanced beyond the stoma, distal to the hole in the anterior tracheal wall (Figure 8.8).

Figure 8.8 Oral intubation with a long (uncut) tube placed distal to the stoma in the trachea.

Reproduced with permission of HEE eLfH.



If the patient has an established tracheostomy, or if the upper airway is known to be difficult, then it may be more appropriate to attempt intubation of the tracheostomy stoma at this point. Simple reinsertion of a smaller tracheostomy tube or endotracheal tube may establish a patent airway, although a 'deeper' stoma may require more advanced or endoscopic techniques. Where possible, a fibreoptic scope should be used to facilitate placement of an airway catheter (e.g. Aintree catheter) or bougie (Figure 8.9). A fibreoptic scope can be used to allow an endotracheal or tracheostomy tube to be 'railroaded' into the trachea and help ensure correct placement. Small, delicate endoscopes may not offer

enough support to a new tracheostomy tube when used as a guide in this way, especially if the neck or trachea is deep. Another advantage of a fibreoptically guided bougie is that they may be able to be connected to a system providing oxygen delivery. Care should be taken when using a high-pressure oxygen supply. If the tip of an airway exchange catheter lies beyond the carina in a smaller bronchus, delivering high-pressure gas flows may cause barotrauma and lead to a pneumothorax. In an emergency situation without availability of a fibreoptic scope, blind or digitally assisted placement of a bougie may be helpful, but the risks of malposition are increased.

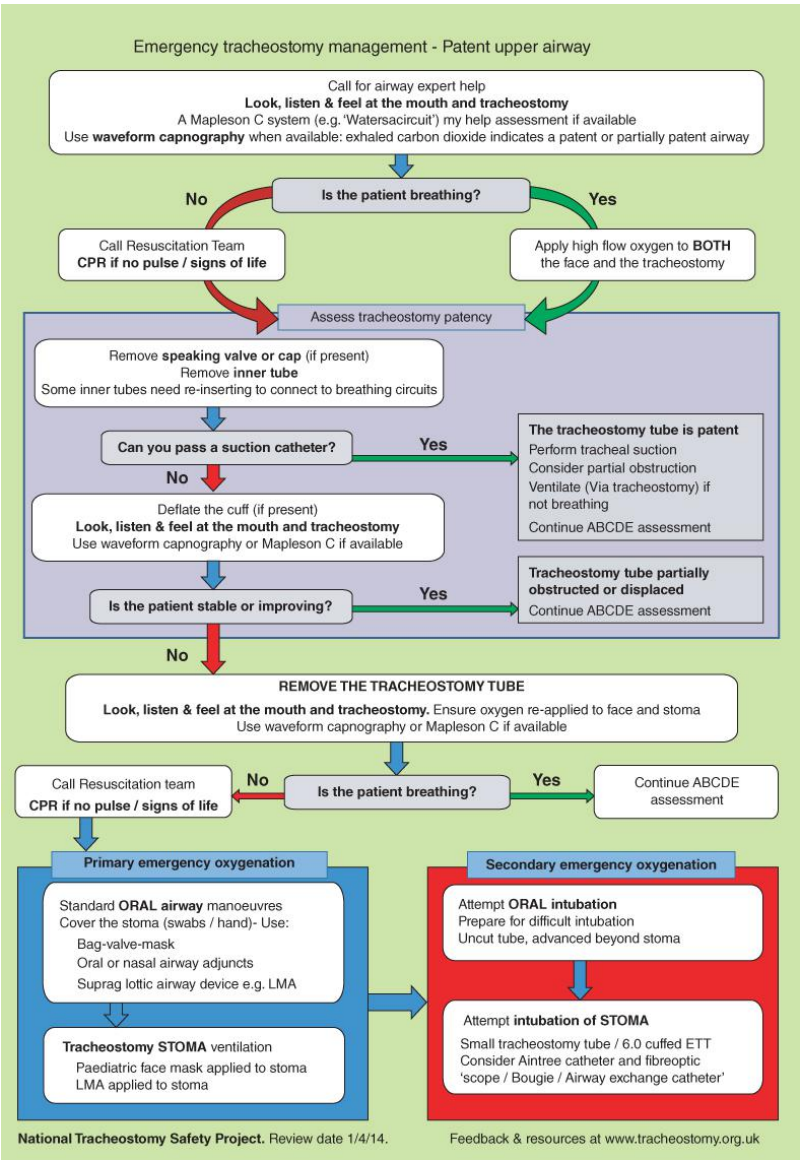
Figure 8.9 Bougie inserted into a tracheostomy tube.

The use of waveform capnography in establishing effective ventilation via a patent airway has been reinforced by recent guidelines and capnography should be available for hospitalised patients in a resuscitation attempt regardless of location. Capnography should be *immediately* available in 'high-risk' locations, such as critical care units or wherever patients are ventilated. It should be *available* in all other areas and the introduction of ward-based defibrillators, which can display waveform capnography, or other bedside devices that detect CO_2 should be encouraged (Figures 8.10 and 8.11).

Figure 8.10 Bedside capnograph.

Figure 8.11 The ‘green algorithm’ for emergency management of patients with patent upper airways.

McGrath (2012). Reproduced with permission of John Wiley & Sons, Inc.


Emergency tracheostomy management - Patent upper airway
Call for airway expert help
Look, listen & feel at the mouth and tracheostomy
A Mapleson C system (e.g. 'Watersacircuit') my help assessment if available
Use waveform capnography when available: exhaled carbon dioxide indicates a patent or partially patent airway
Is the patient breathing?
No
Yes
Call Resuscitation Team
CPR if no pulse / signs of life
Apply high flow oxygen to BOTH the face and the tracheostomy
Assess tracheostomy patency
Remove speaking valve or cap (if present)
Remove inner tube
Some inner tubes need re-inserting to connect to breathing circuits
Can you pass a suction catheter?
Yes
The tracheostomy tube is patent
Perform tracheal suction
Consider partial obstruction
Ventilate (Via tracheostomy) if not breathing
Continue ABCDE assessment
No
Deflate the cuff (if present)
Look, listen & feel at the mouth and tracheostomy
Use waveform capnography or Mapleson C if available
Is the patient stable or improving?
Yes
Tracheostomy tube partially obstructed or displaced
Continue ABCDE assessment
No
REMOVE THE TRACHEOSTOMY TUBE
Look, listen & feel at the mouth and tracheostomy. Ensure oxygen re-applied to face and stoma
Use waveform capnography or Mapleson C if available
Call Resuscitation team
CPR if no pulse / signs of life
No
Is the patient breathing?
Yes
Continue ABCDE assessment
Primary emergency oxygenation
Standard ORAL airway manoeuvres
Cover the stoma (swabs / hand)- Use:
Bag-valve-mask
Oral or nasal airway adjuncts
Suprag lottic airway device e.g. LMA
Tracheostomy STOMA ventilation
Paediatric face mask applied to stoma
LMA applied to stoma
Secondary emergency oxygenation
Attempt ORAL intubation
Prepare for difficult intubation
Uncut tube, advanced beyond stoma
Attempt intubation of STOMA
Small tracheostomy tube / 6.0 cuffed ETT
Consider Aintree catheter and fibreoptic
'scope / Bougie / Airway exchange catheter'
National Tracheostomy Safety Project. Review date 1/4/14.
Feedback & resources at www.tracheostomy.org.uk

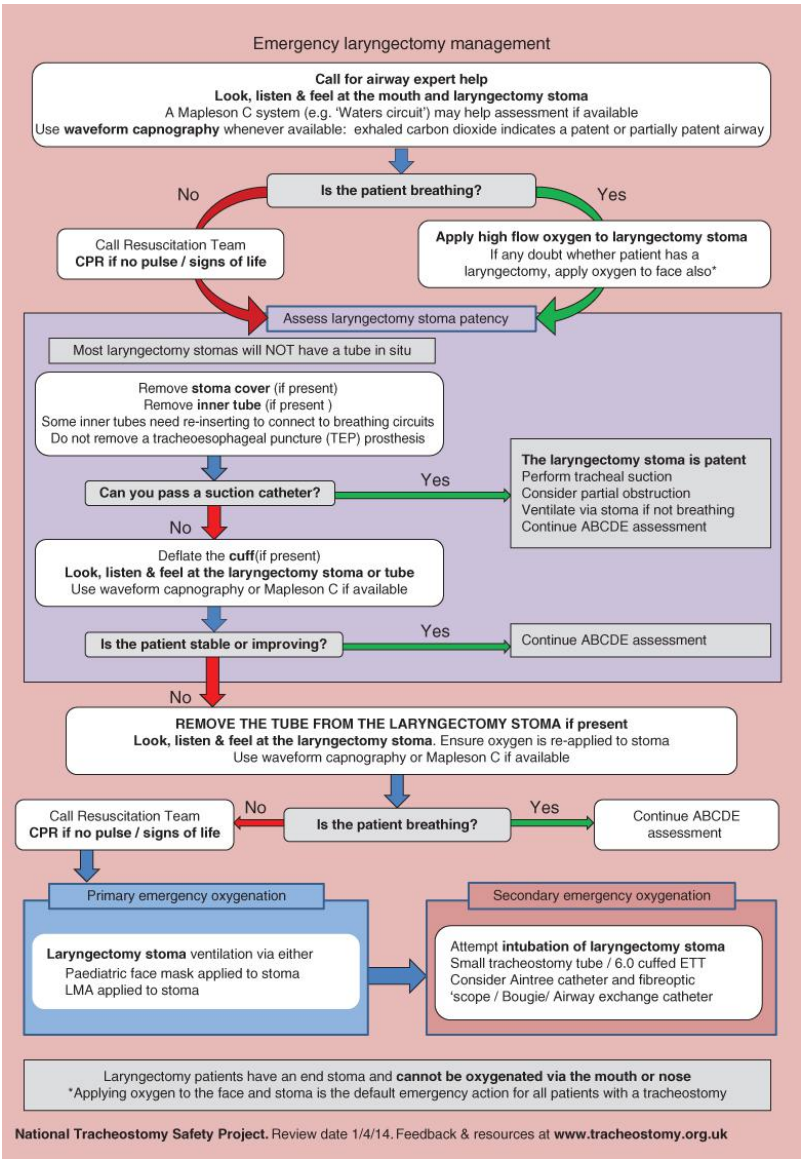
Laryngectomy: the ‘Red algorithm’

This algorithm is paired with the red bedhead sign and indicates that the patient does not have an upper airway which is connected to the lungs. The principles of the algorithm are the same, without the conventional upper airway management steps described. Patients with laryngectomies usually do not have a tracheostomy tube *in situ*, but may have other devices inserted into their airways, such as humidifiers or ‘TEP’ valves. As previously discussed, these devices should not be removed. The exclusion of the upper airway means laryngectomy patients will not obstruct their airway when lying flat on their backs and aspiration of gastric contents is not a concern. In the context of cardiopulmonary resuscitation, chest compressions will generate more significant tidal volumes owing to a reduction in dead space. Oxygen insufflation alone without ventilation may be effective if ventilation proves difficult (Figures 8.12 and 8.13).

Figure 8.12 Laryngectomees have no upper airway.

Figure 8.13 The ‘red algorithm’ for emergency management of laryngectomy patients.

McGrath (2012). Reproduced with permission of John Wiley & Sons, Inc.


Emergency laryngectomy management
Call for airway expert help
Look, listen & feel at the mouth and laryngectomy stoma
A Mapleson C system (e.g. 'Waters circuit') may help assessment if available
Use waveform capnography whenever available: exhaled carbon dioxide indicates a patent or partially patent airway
Is the patient breathing?
No
Yes
Call Resuscitation Team
CPR if no pulse / signs of life
Apply high flow oxygen to laryngectomy stoma
If any doubt whether patient has a laryngectomy, apply oxygen to face also*
Assess laryngectomy stoma patency
Most laryngectomy stomas will NOT have a tube in situ
Remove stoma cover (if present)
Remove inner tube (if present)
Some inner tubes need re-inserting to connect to breathing circuits
Do not remove a tracheoesophageal puncture (TEP) prosthesis
Can you pass a suction catheter?
Yes
The laryngectomy stoma is patent
Perform tracheal suction
Consider partial obstruction
Ventilate via stoma if not breathing
Continue ABCDE assessment
No
Deflate the cuff(if present)
Look, listen & feel at the laryngectomy stoma or tube
Use waveform capnography or Mapleson C if available
Is the patient stable or improving?
Yes
Continue ABCDE assessment
No
REMOVE THE TUBE FROM THE LARYNGECTOMY STOMA if present
Look, listen & feel at the laryngectomy stoma. Ensure oxygen is re-applied to stoma
Use waveform capnography or Mapleson C if available
Call Resuscitation Team
CPR if no pulse / signs of life
No
Is the patient breathing?
Yes
Continue ABCDE assessment
Primary emergency oxygenation
Laryngectomy stoma ventilation via either
Paediatric face mask applied to stoma
LMA applied to stoma
Secondary emergency oxygenation
Attempt intubation of laryngectomy stoma
Small tracheostomy tube / 6.0 cuffed ETT
Consider Aintree catheter and fibreoptic 'scope / Bougie/ Airway exchange catheter
Laryngectomy patients have an end stoma and cannot be oxygenated via the mouth or nose
*Applying oxygen to the face and stoma is the default emergency action for all patients with a tracheostomy
National Tracheostomy Safety Project. Review date 1/4/14. Feedback & resources at www.tracheostomy.org.uk

A patient with a tracheostomy is more likely to come to harm by not having oxygen applied to the face if confusion surrounds the nature of the

stoma. **The default emergency action is to apply oxygen to the face and the stoma for all neck breathers when there is any doubt as to the nature of a stoma**. Any oxygen applied to the upper airway can be removed in the case of a laryngectomy once this has been confirmed to be the case. Ventilation via laryngectomy stomas can be achieved directly using paediatric face masks or laryngeal masks applied to the anterior neck.

An interactive laryngectomy algorithm with videos highlighting key steps can be viewed on the website www.tracheostomy.org.uk.

Comparison with previously published guidelines

The way in which the NTSP guidelines have been developed is unique. As a result, specific differences with other previous guidelines are evident. The following are features of the NTSP algorithms.

1. Waveform capnography has a prominent role at an early stage in emergency management.

2. Oxygenation of the patient is prioritised.

3. Trials of ventilation via a potentially displaced tracheostomy tube to assess patency are avoided.

4. Suction is only attempted after removing a potentially blocked inner tube.

5. Oxygen is applied to both potential airways.

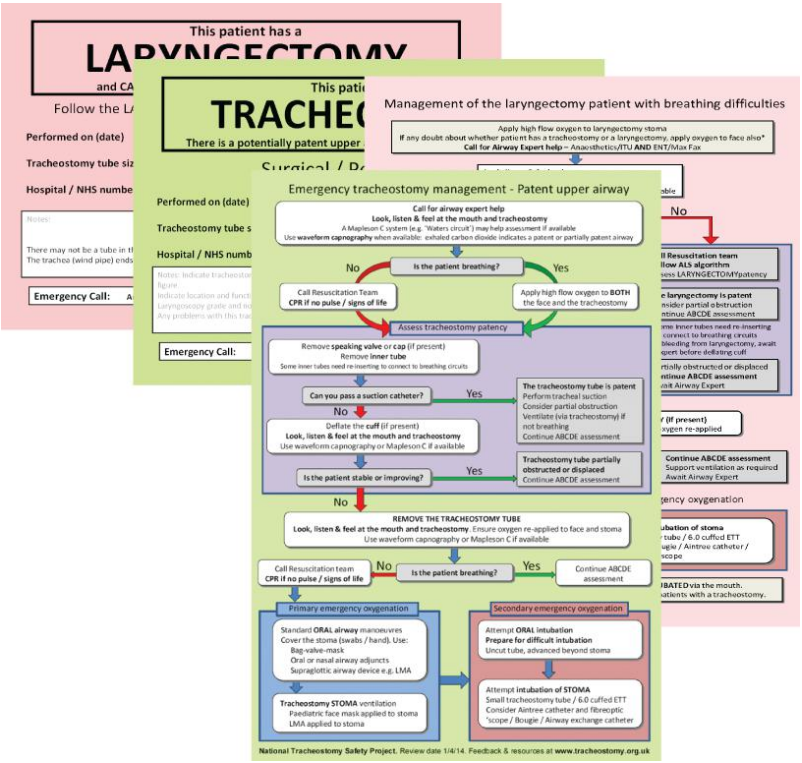
6. Simple methods to oxygenate and ventilate via the stoma are described.

7. A blocked or displaced tracheostomy tube is removed as soon as this is established, not as a 'last resort'.

In addition, previous guidance for tracheostomy emergencies has generally not been published as an algorithm, making it difficult to follow in emergency situations. Where algorithms have been used, they are often complex and not easily followed when tested in simulated emergencies. No other algorithms are colour coded and none are presented paired with

bedhead signs (Figure 8.14). No emergency guidance was applicable to all situations (critical care, ventilated patients, surgical vs percutaneous tracheostomy, community patients) and many offered no 'Plan B' if the initial measures failed to resolve the situation.

Figure 8.14 Bedhead signs are paired with the corresponding algorithm and, if present at the bedside, can help guide emergency management.


This patient has a
LARYNGECTOMY
Follow the L
Performed on (date)
Tracheostomy tube siz
Hospital / NHS numbe
Emergency Call:
TRACHE
There is a potentially patent upper
Performed on (date)
Tracheostomy tube s
Hospital / NHS numb
Emergency Call:
Management of the laryngectomy patient with breathing difficulties
Apply high flow oxygen to laryngectomy stoma
If any doubt about whether patient has a tracheostomy or a laryngectomy, apply oxygen to face also*
Call for Airway Expert help – Anaesthetics/ITU AND ENT/Max Fax
No
Emergency tracheostomy management - Patent upper airway
Call for airway expert help
Look, listen & feel at the mouth and tracheostomy
A Mapleson C system (e.g. 'Waters circuit') may help assessment if available
Use waveform capnography when available: exhaled carbon dioxide indicates a patent or partially patent airway
Is the patient breathing?
No
Yes
Call Resuscitation Team
CPR if no pulse / signs of life
Apply high flow oxygen to BOTH
the face and the tracheostomy
Assess tracheostomy patency
Remove speaking valve or cap (if present)
Remove inner tube
Some inner tubes need re-inserting to connect to breathing circuits
Can you pass a suction catheter?
Yes
No
The tracheostomy tube is patent
Perform tracheal suction
Consider partial obstruction
Ventilate (via tracheostomy) if not breathing
Continue ABCDE assessment
Deflate the cuff (if present)
Look, listen & feel at the mouth and tracheostomy
Use waveform capnography or Mapleson C if available
Is the patient stable or improving?
Yes
Tracheostomy tube partially obstructed or displaced
Continue ABCDE assessment
No
REMOVE THE TRACHEOSTOMY TUBE
Look, listen & feel at the mouth and tracheostomy. Ensure oxygen re-applied to face and stoma
Use waveform capnography or Mapleson C if available
Call Resuscitation team
CPR if no pulse / signs of life
No
Is the patient breathing?
Yes
Continue ABCDE assessment
Primary emergency oxygenation
Standard ORAL airway manoeuvres
Cover the stoma (swabs / hand). Use:
Bag-valve-mask
Oral or nasal airway adjuncts
Supraglottic airway device e.g. LMA
Tracheostomy STOMA ventilation
Paediatric face mask applied to stoma
LMA applied to stoma
Secondary emergency oxygenation
Attempt ORAL intubation
Prepare for difficult intubation
Uncut tube, advanced beyond stoma
Attempt intubation of STOMA
Small tracheostomy tube / 6.0 cuffed ETT
Consider Aintree catheter and fibreoptic
'scope / Bougie / Airway exchange catheter
National Tracheostomy Safety Project. Review date 1/4/14. Feedback & resources at www.tracheostomy.org.uk

[1] http://www.ncbi.nlm.nih.gov/pubmed?term = Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies.

[2] http://www.youtube.com/watch?v=7OR8pyHzE44

[3] http://www.youtube.com/watch?v=YTFjUv4s_Ks

Chapter 9

Paediatric tracheostomy care (with Great Ormond Street Hospital, London)

This section details some of the specific guidance available for medical and nursing staff, allied health professionals, patients, parents and carers who are involved in the care of a child with a tracheostomy. It has been adapted from the Great Ormond Street Hospital, London (GOSH) paediatric tracheostomy guidelines.

These guidelines were originally written by:

- Sr Joanne Cooke TD MSc RGN RSCN, Advanced nurse practitioner, GOSH;
- Miss Michelle Wyatt MA (Cantab), FRCS (ORL-HNS), Consultant Paediatric ENT Surgeon, GOSH.

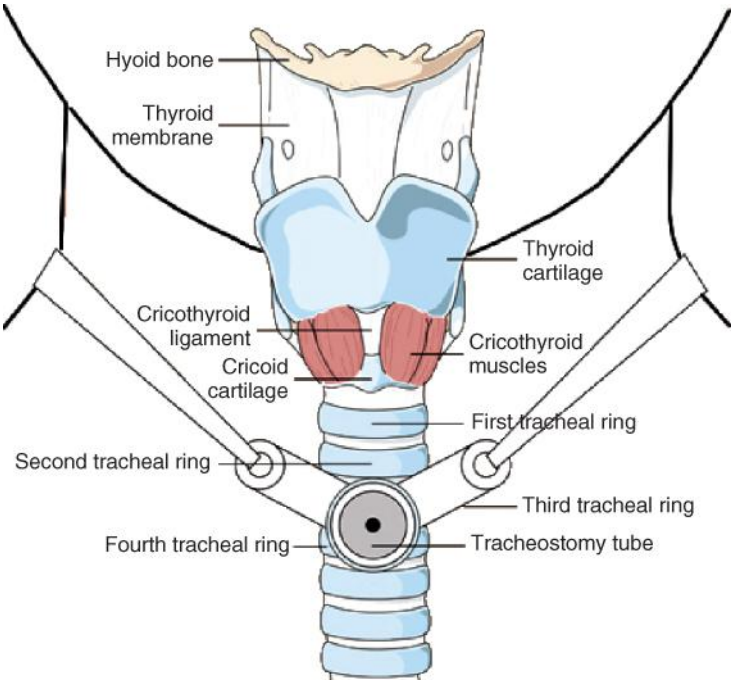
Background

More children with chronic medical conditions are surviving, largely because of advances in medical and tracheostomy care and technology support. The vast majority of these children are now being cared for in their own homes and at school.

Tracheostomy is one of the oldest surgical procedures and was first successfully performed on children in the late 19th century. Today, it is a common procedure and is life saving for many infants and children requiring airway and respiratory support. However, despite providing a safe and 'protected' airway, paediatric tracheostomy is often associated with significant morbidity and mortality.

A tracheostomy is an artificial opening in the trachea, usually between the third and fourth tracheal rings (see Figure 9.1) into which a tube is inserted and through which the child breathes. A tracheostomy is initially a life-*saving* operation, but is also a life-*threatening* one unless the airway is kept clear from secretions and blockages 24 h a day.

Figure 9.1 Paediatric airway anatomy—anterior view with a tracheostomy tube *in situ*.



Children with tracheostomies require constant supervision from those trained fully in their care.

Indications for tracheostomy in a child

The following are the most common indications for tracheostomy in children include.

1. **Cystic hygroma**: An anomaly of the lymphatic system. It is a soft, smooth, non-tender mass of almost fat-like consistency. It is grey and oedematous in appearance. It can involve the neck,

mucosal surfaces of the mouth, tongue, larynx and pharynx, causing a potential airway obstruction.

2. Haemangioma: A swelling containing abnormal blood vessels that can form at all levels of the respiratory system. As the child grows, the haemangioma growth slows, with or without treatment, but it can initially obstruct the airway, which requires support.

3. Laryngomalacia: The structures of the larynx are particularly soft and collapse inwards as the child breathes. This can cause varying degrees of obstruction. As the child grows older, the larynx becomes more rigid and the condition may resolve, allowing for decannulation.

4. Papillomatosis: Benign wart-like lesions that are caused by the human papilloma virus. Their growth and the extent of disease varies considerably in children, but essentially the lesions can occupy and obstruct any part of the child's airway from the mouth and nose right through to lower airway structures.

5. Sub-glottic stenosis: A narrowing of the upper part of the trachea just below the larynx. This may be congenital or acquired usually from prolonged intubation periods and or trauma at the time of tube insertion. Depending on the extent, a child may recover from this or will require reconstructive surgery later in life.

6. Tracheal stenosis: Narrowing of the tracheal diameter, which may be congenital or acquired, possibly through trauma or previous surgery. If the stenosis is high enough, the trachea may be stented by the tracheostomy tube; if not, separate tracheal stents may have to be inserted to support the affected areas.

7. Tracheomalacia: An area of softening in the trachea, which may collapse inwards as the child breathes and may obstruct respiration. This condition usually resolves with time as the trachea enlarges and becomes more rigid. The tracheostomy tube may be useful in stenting the area of the collapse. Some children may require positive pressure ventilatory support if the lower tracheal area is collapsing.

8. Bronchomalacia: An area of softening in one or both of the bronchus, which may collapse inwards as the child breathes. As with all malacia, this condition usually resolves as the child becomes older. Until this time, the child may require positive pressure ventilatory support.

9. Trauma: Direct trauma (e.g. burns) to the upper airway or surrounding structures can cause a potential airway obstruction and/or narrowing.

10. Vocal cord immobility: Immobile vocal cords may be caused by injury during intubation and/or surgery, or may be because of an underlying neurological condition. Depending on whether the cords are fixed open or closed, the airway may be compromised.

11. Tumour: Tumours of any part of the respiratory passage may cause an airway obstruction, because of the potential nature, growth and shape.

12. Long-term respiratory support: A tracheostomy may be required to facilitate long-term respiratory support, which would otherwise have to be managed with an endotracheal tube. The latter would lead to a variety of problems: including security of the tube, stimulation and development of the child; it would also mean hospitalisation. A tracheostomy is the preferred long-term option.

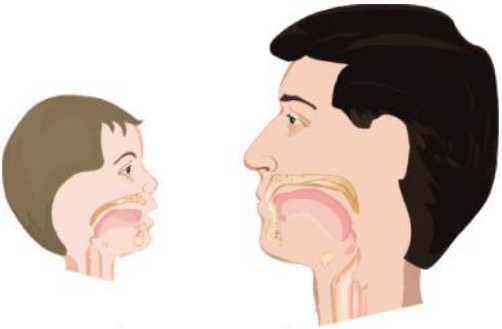
13. Lung disorders: Chronic lung disease can result from prolonged ventilation, aspiration, infection or congenital defects.

14. Neuromuscular conditions: A variety of congenital or acquired conditions can lead to the need for a tracheostomy either to 'protect' the airway from aspiration.

Differences between adult and paediatric airways

There are a number of important anatomical and physiological differences between the adult and paediatric airways (Figure 9.2). Clearly, there are emotional, psychological and practical differences to also address, including the additional relationships that must be forged between the tracheostomy teams and the child and the parents.

Figure 9.2 (a) Relative differences between adult and paediatric airways. Note the relative sizes of the tongue and the angle of the epiglottis and (b) The laryngeal aperture of a child is relatively (and physically) smaller than the adult.



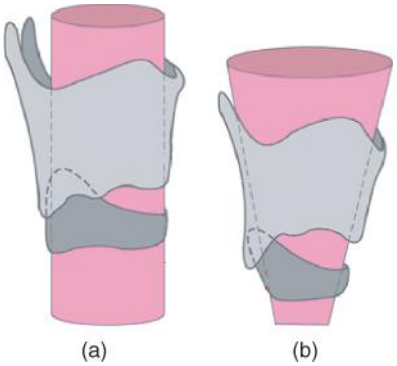
(a)

(b)

The child's cervical spine is more flexed than that of an adult and this combined with the relatively larger head and tongue, predisposes to airway obstruction. The larynx itself is situated higher in the neck than in the adult and the epiglottis is longer and less flexible. Intubation is performed in a slightly modified way in the child, often using a straight blade to elevate the epiglottis from 'behind'. A more conventional (adult) blade can usually be employed from 12–18 months of age depending on the child and operator preferences. By the age of 8, most children can be considered to have an adult larynx, although of much smaller calibre.

The narrowest part of a child's airway is at the level of the cricoid (see Figure 9.3). This can be as small as 4 mm in the neonate. A minor degree of swelling or airway obstruction will cause a significant increase in resistance to airflow.

Figure 9.3 In the child's larynx (a), the airway is narrowest at the cricoid in contrast to that of the adult (b).



Nursing and general care of the paediatric tracheostomy patient

Preparation of essential equipment and environment

The child's bed area must always be made easily accessible from both sides without obstruction, as the child's airway is at risk and may need immediate attention. All bedside equipment must be checked whenever a practitioner takes over the care of a 'tracheostomised' child, including breaks and transfers to another ward/department. The child **MUST NEVER** be left alone.

The accompanying carer (including parents, where applicable), as a minimum, must be able to:

- recognise signs of airway obstruction
- initiate suctioning of tracheostomy tube.

The child should have a dedicated tracheostomy trolley by the bedside containing:

- oxygen saturation monitoring—if oxygen therapy is required
- suction catheters—correct size to safely suction tracheostomy tube
- clean gloves to minimise the risk of cross-contamination
- clean gauze to clean stoma/secretions
- clean receiver with tap water to flush through suction tubing after use
- 2 ml syringe
- ampoules of 0.9% sodium chloride for irrigation
- yellow waste bag 'for incineration'
- goggles/protective eye wear should be available
- an 'emergency trachi box' with the following contents:
    - a spare tracheostomy tube (same size and make)
    - a tracheostomy tube (one size smaller)
    - a water-based lubricant, such as Aqualube ® or KY Jelly®
    - round-ended scissors (safer cutting of tapes)
    - spare tracheostomy tapes
    - a suction catheter (same ID as the suction catheter) to 'railroad' a new tube into the stoma (Seldinger technique).

Appropriate resuscitation and suction equipment with correct tracheostomy fittings (15 mm swivel connector and a male adaptor for GOS, Silver & Montgomery tubes) checked and in full working order. A tube with a 15 mm termination requires a Smiths Medical (Portex©) swivel connector, which can be added to the resuscitator and must be available at the child's bedside. A flat-ended tube requires an appropriately sized tracheal tube adapter and a Smiths Medical (Portex) swivel connector that will 'slip into' the tube as required to create a 15 mm termination that will be compatible with resuscitation equipment.

As with adult patients, tracheal dilators are not automatically recommended as essential bedside equipment. They should be *available* in the immediate area but not necessarily at the bedside unless specifically required. They should only be used by staff who are competent to do so.

Initial care following tracheostomy

Nursing actions during the first 7 days following formation of the tracheostomy centre on maintaining the correct positioning and patency of the new tube, stoma maintenance and parental teaching (if appropriate). As with newly formed adult tracheostomies, replacing a paediatric tracheostomy tube within the first week can be problematic and so the focus of care is ensuring the existing tube remains patent. Communication between the hospital and community health carers must be commenced following surgery to ensure effective and timely discharge planning.

The initial nursing care of a child with a tracheostomy is very different from that for an established stoma. At GOSH, the first tube change occurs after 1 week, which allows sufficient time for the stoma tract to mature. Other units have advocated changing the tube after as little as 3 days. The Tracheostomy Nurse Practitioner (TNP) or an appropriate head and neck surgeon will perform the first tube change.

To ensure the safety of the airway, the trachea is sometimes sutured onto the child's skin with tiny interrupted disposable sutures—these are called ‘maturation sutures’. These ‘maturation sutures’ will help to form a more permanent and safer stoma, especially if the tube requires changing in the first week. In addition, two long-looped ‘stay’ sutures extend from inside the stoma and are taped to the child's chest (Figure 9.4). These sutures are attached to the tracheal wall on either side of the stoma. These ‘stay sutures’ will assist with the opening of the stoma during the first week, by raising the trachea to the skin surface and pulling the stoma apart so that a tube can be inserted. The tape on the child's chest will be labeled ‘**DO NOT REMOVE**’ (for the first 7 days following the procedure) and will be removed after the first tube change.

Figure 9.4 The position of stay sutures taped to the child's chest.

Observations

The child's vital signs should be recorded in accordance with local policy, with the frequency reducing as the child's condition dictates. Practitioners should also carry out routine non-invasive observations to rule out the following potential initial complications.

- Check that the tape tension is correct and able to support the tracheostomy tube.
- Observe if there is any neck swelling (surgical emphysema—see subsequent text).
- Check for air entry through tube—place finger above tube opening and feel for the flow of air against your finger.
- Inspect the chest for bilateral chest movement.
- Auscultate the chest for equal air entry (pneumothorax/tube position).

A flexible endoscopy may be performed post-operatively if the child is distressed and or coughing.

Post-procedural tube check

For the majority of children, a chest radiograph is performed in the theatre; if this has not happened, then a portable post-operative chest radiograph must be performed within 1 h or soon after the child has returned to the ward to confirm tube position and to rule out a pneumothorax and surgical emphysema (Figure 9.5).

Figure 9.5 Post-procedural chest radiograph in an infant.

Other initial complications

Initial complications are largely avoidable if the procedure is carefully performed together with careful and effective post-operative management.

Listed here are the other initial complications.

Haemorrhage

May be primary, reactionary or secondary. A large haemorrhage may be fatal. Secretions may initially be blood stained but will settle within a few hours. If it continues, practitioners should contact the appropriate specialist tracheostomy or surgical team.

Tube blockage

Although children should only be suctioned when required, it is imperative that a new tracheostomy tube is kept patent at all times.

Children must be nursed in continuous humidity for the first week (may come off for short periods only). To reduce the incidence of tube occlusions, suction should be performed:

- at least half—hourly suction for the first 12–24 h
- as required until the first tube change.

Accidental decannulation/tube displacement

This is always a risk with a new tracheostomy. Common causes include chubby infant neck, incorrectly chosen tube, loose tapes or the child pulling at the tube. Risks can be minimised by appropriate choice of tube size and type, careful insertion technique and careful nursing. Check correct tension of the tapes securing the tube, ensuring that only one finger slips between the neck and tapes (Figure 9.6). Close observation is required: respiratory rate, effort, chest movements and air entry on return to the ward, coupled with direct observation of the tube itself. The tube may visibly come out of the stoma or can be pulled out of the trachea and sit in the pre-tracheal tissues. In this situation, the tube can be re-inserted by an appropriately trained person, but must not be forced. On reinsertion, air entry must be checked and confirmed and the appropriate clinical team must be contacted immediately to review tube position.

Figure 9.6 One finger should slip comfortably between the ties and the child's neck.

Infection (chest/stoma site)

The stoma site must be cleaned daily or when soiled using a clean technique and sterile gauze/saline. The wound must be inspected for signs of inflammation and/or infection. Observe colour and nature of secretions.

Surgical emphysema

Air may leak around the tube into the surrounding tissue—this is particularly problematic if the child has had neck sutures inserted. Checking tape tension not only confirms that the tube is secured correctly but may also be an indication of swelling if they appear tighter. Contact the appropriate clinical team for review.

The child, where possible, should not leave the ward during the first week unless medically indicated as the airway is at risk, and must remain in an environment that can manage any complications.

Feeding

If there have been no previous feeding concerns, the child may recommence normal feeds after a specified time of being 'nil orally'. This is normally 3 hours post operation, but practitioners must confirm this with the anaesthetic chart or team. The vocal cords are often sprayed during the procedure, making them less responsive/effective in protecting the airway from aspiration. Other (sometimes pre-existing) physical complications accompanied by post-surgical oedema, restrict laryngeal elevation. This prevents the complete and safe closure of the lower respiratory tract and may cause aspiration and/or regurgitation of food.

For a child who has had feeding difficulties or has never been orally fed, consultation with the SALT should be sought before the commencement of oral feeding. Begin with water. If the child shows signs of aspiration, for example, if there is coughing after/during drinking, or visible drink coming out of the tracheostomy, then maintain nil orally and contact the ENT team and the SALT.

Humidification

GOSH do not use an HME in the first week following a new tracheostomy. The HME does not provide enough humidity in the initial phase to prevent tube occlusion in the first week. Administer humidity via sterile water and elephant tubing continuously for 1 week, as far as is practicable. The child may come off for short periods, that is, to feed, play, bathe, mobilise, and so on. Small and vulnerable infants under 1 year must have continuous warmed humidity.

Change humidity apparatus when the bottled water needs changing (usually 24 h) or earlier if contaminated with secretions or if the mask comes into contact with the floor. When not in use, the mask should be covered.

Other care needs

Given here is a list of other care needs.

- Change the tapes at least **daily** or when soiled or wet.
- A suitable dressing, such as Trachi-dress®, should be inserted behind the flanges to protect the skin (shiny side to skin; Figure 9.7). Avoid using bulky substitutes as these may pull the tube away from the neck precipitating accidental decannulation.
- **Never** use cotton wool or cut gauze dressings (keyhole) as flecks of displaced cotton may enter the respiratory tract.
- At GOSH, the first tube change occurs after 1 week, which allows sufficient time for the stoma tract to mature. The TNP or an appropriate head and neck surgeon will perform the first tube change. The 'stay sutures' will be removed at this time.

Figure 9.7 Suitable dressings should be inserted behind the flanges to protect the skin.

Once the stability of the tracheostomy stoma and tract has been verified the child may be allowed off the ward with a person appropriately trained in routine and emergency tracheostomy skills.

Routine management of the paediatric tracheostomy patient

Suctioning

Airway suctioning is a common practice in the care of a child with a tracheostomy, and is undertaken to remove secretions from the child's respiratory tract. A child with a tracheostomy may find it difficult to clear the secretions effectively; therefore, suction is an essential aspect of their care. Suctioning is associated with many potential complications and is now only recommended when there are clear indications that the patency or ventilation of the children could be compromised. Suctioning a paediatric tracheostomy is very different from suctioning an adult tube, so adult practitioners will need to adapt their practice.

Potential complications of suctioning include:

- hypoxia
- formation of distal granulation tissue/ulceration
- cardiovascular changes
- pneumothorax
- atelectasis
- bacterial infection

- intracranial changes.

Practitioners trained in the skill should perform tracheostomy suctioning to minimise complications and maximise treatment. The child and family must be informed of the reasons for suctioning, positioning, risks and outcomes as appropriate. A 'clean' technique must be used and the catheter should be discarded if the tip is contaminated with hands, cot sides, and so on. Suction equipment must accompany the child at all times, regardless of the nature of the journey or the distance to be travelled.

Suctioning equipment

The following equipment should be prepared.

- Suction catheters of the correct size
- Suction unit with variable vacuum control
- Gloves
- Apron (don if there is time—a child should never wait for suctioning)
- Tap water (in clean container)
- A 2 ml syringe with 0.9% sodium chloride for irrigation (not for routine suctioning)
- Yellow waste bag 'for incineration'.

Practitioners must be aware that some pre-term, vulnerable infants and especially those who are requiring >40% inspired oxygen, may require pre-oxygenation prior to suctioning to minimise the potential for hypoxia following suction. Distal tracheal damage and hypoxia are very real potential complications in the vulnerable paediatric airway. These complications may be reduced in the following manner.

- The correct size catheter; as a guide, practitioners should double the size of the tracheostomy tube to obtain the appropriate catheter size (e.g. 4.0 ID tracheostomy tube = size 8F catheter). A suction catheter diameter should be less than half of the size of the tracheostomy tube to reduce potential for hypoxia and allow the child to breathe throughout the procedure.
- One distal and two lateral ports with rounded ends allow secretions to be collected both distally and from the sides of the tube to

minimise tube occlusion. Catheters with more than three lateral holes may render the wall too weak (Figure 9.8).

- The lateral port should be smaller than the distal port so that mucosal adhesion and biopsy does not occur.
- An integrated valve for vacuum control, as suction should only be applied on removal. Catheters should not be kinked prior to insertion in an effort to control the vacuum.
- It is preferable to use suction catheters with graduations, so that practitioners can measure the exact depth to be suctioned. Suctioning should not occur distal to the tube tip. Catheters should only be inserted so that the distal hole sits at the end of the tube. This allows collection of secretions but not trauma to the distal tracheal mucosa.
- Suction pressures should be kept to a minimum as excessive pressures can cause trauma, hypoxaemia and atelectasis. As a general guide, pressures should not exceed:
  - 60–80 mmHg (8–10 kPa) for neonates/small infants
  - up to 120 mmHg < 16 kPa for older children.

Figure 9.8 Paediatric suction catheters.

Table 9.1 offers a more specific guide to suction pressures required with different sized paediatric tracheostomy tubes.

Table 9.1 A guide to tube sizes and suction pressures in paediatric patients.

Age of child	Approximate tube size	Suction pressures
Pre-term—1 month	3.0	8–10 kPa

		60–75 mmHg
0–3 years	3.5–5.0	10–12 kPa
		75–90 mmHg
3–10 years	5.0–6.0	12–15 kPa
		90–112 mmHg
10–16 years	6.0–7.0	15–20 kPa
		112–150 mmHg

Adapted from GOSH guidelines, Billau (2004), Dean(1997), Mowery (2002), Simpson (2009) and Young (1984).

Suctioning is not a painful or distressing procedure; in fact, most infants will remain asleep throughout. If the child becomes distressed during suctioning then practitioners should review their technique. Constant observation of the child during suctioning is essential; practitioners should observe for an improvement or deterioration in respiratory rate and quality, the child's colour and oxygen saturations (if monitored).

Paediatric suctioning technique

1. Perform a clinical hand wash (if there is time) and put on a minimum of gloves.

2. Turn suction unit on and check the vacuum pressure and set to the appropriate level, according to the child's age.

3. The carer must know the length of the tracheostomy tube. If the tube is fenestrated then an un-fenestrated inner tube should be inserted. This will prevent the catheter going through the fenestration and causing trauma, although practically, trying to suction through a fenestrated inner tube is more likely to ‘catch’ the suction catheter on insertion and lead to inappropriate concerns that the tube is blocked.

4. Do not apply suction on insertion as this may cause mucosal irritation, damage and lead to hypoxia.

5. Insert catheter gently into the tracheostomy tube, enough to ensure that the lateral and distal holes just pass through the tip of the tube, use the graduations on the catheter as a guide. Adult

literature suggests longer distances; however, the distance between the tube tip and a child's carina could only be a matter of millimetres.

6. Handle only the proximal end of the catheter. Catheters should be discarded if the end has been touched before insertion.

7. Apply suction by placing thumb over the valve, found either on catheter or suction tubing. Kinking the catheter (to stop suction and then apply it) can result in unpredictable negative pressures and is not recommended. An intermittent suction technique does not reduce trauma and is less effective.

8. Slowly withdraw the catheter straight out of the tube maintaining the vacuum.

9. There is absolutely no need to rotate the suction catheter on withdrawal, as both the distal and lateral holes on the newer style of catheter allows for circumferential suctioning.

10. Suctioning should be quick but effective and should not exceed 5–10 s. In paediatrics, maximum durations should be based on the child's underlying medical and current clinical condition. Practitioners should adjust timings accordingly, for example, 10 s is a long time for a neonate with underlying lung disease.

11. The catheter may be reused if immediate suction is required, as long as secretions have not occluded the suction ports. If the distal end of the catheter has not been contaminated prior to the suctioning episode, then there is no evidence to suggest that by using the same catheter up to three times at the same suctioning episode increases the risk of infection. In fact with effective re-training on technique, some institutions have repeatedly used the same catheter on the same patient for a 24-h period and have reported no increase in infection.

12. Wrap the catheter around the gloved hand, remove the glove by inserting it over the used catheter and discard in yellow waste bag according to Waste Policy.

13. Flush suction tubing with tap water to clear secretions from the suction tubing and connect a new catheter to the tubing.

14. Wash hands.

Record if the secretions are bloody, purulent, foul smelling or unusually thick in the child's healthcare records. Take samples as required.

Deep suctioning may be required in certain circumstances—for example, during broncho-alveolar lavage—but this should not be routine practice. Saline should not be used routinely.

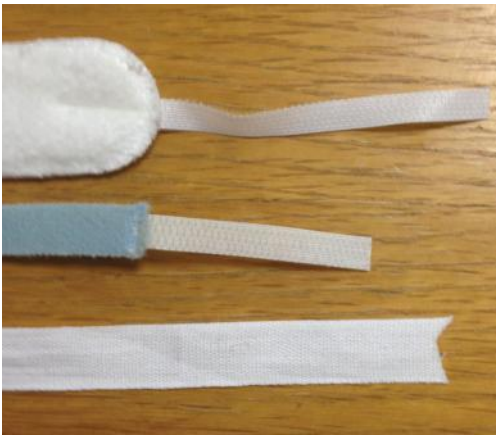
Tape changes (cotton)

A tracheostomy tube is held in place with cotton tapes around the neck. It is essential that the ties are secure and the tension of the ties is correct. The tapes are secured with knots tied on either side of the tracheostomy tube.

Velcro ties are not routinely used at GOSH. This is because of fatal incidents involving Velcro becoming stuck to bedding and contributing to accidental decannulation. If children arrive with Velcro ties, these will usually be replaced with cotton tapes for the duration of their stay, following an appropriate explanation to parents and carers. Velcro ties may be used in certain situations and institutions if local risk assessment allows.

Tracheostomy tape changes are normally performed daily. Only personnel trained and competent in the techniques involved must change tracheostomy tapes and two people are required. All staff/parents should be taught to tie the tapes in the same way to ensure continuity of care. Parents may prefer to adopt another method of securing the tapes once they have established a routine at home. This method may be continued when the child is re-admitted to hospital but will need individual assessment (Figure 9.9).

Figure 9.9 Velcro and cotton ties.



Equipment

The following should be prepared and be readily available.

- Appropriate emergency equipment—in case of accidental decannulation
- Gauze swabs and saline sachets
- Two lengths of ¼-in. cotton tape with short plastic backing; the backing made from appropriately sized available tubing, for example, 24 h urine or O_2 tubing
- Cut the ends of the tapes to be cut to a point to allow easier insertion through the flanges of the tube
- Round-ended scissors
- A rolled up towel placed under the child's shoulders to hyperextend the neck, making observation and cleaning of the stoma easier
- A blanket to swaddle a baby or uncooperative toddler as movement during the procedure may lead to accidental decannulation. Involve the play specialist where possible. Most children will settle once they get used to the procedure and especially when parents begin to carry it out.
- Suction equipment (see suction guidelines)
- Non-sterile gloves and an apron with goggles/protective eye wear
- Child's own comforter, for example, dummy, as appropriate
- An older child may not require swaddling. Some children may assist with the procedure by holding the tracheostomy tube in place

and some may even prefer to sit during a change. These options must be discussed with the child and parents/carers, as swaddling the child may cause increased distress.

Technique to change the tracheostomy tapes

1. Perform a clinical hand wash, put on gloves, apron and protective eye wear (parents do not need to wear the protective clothing).

2. The warmed water should be poured onto the gauze swabs.

3. Assistant to swaddle baby, exposing shoulders and above. Place baby/child in supine position, with a rolled up towel under the shoulders.

4. Place clean tapes behind the baby/child's neck.

5. Assistant should hold tube in position using either the thumb and index finger, or index and middle finger, to support the tube and minimise the risks of accidental decannulation (see Figure 9.10). Minimal pressure should be applied.

6. The person designated to change tapes should cut the tapes between the knot and the flange and remove dirty ties.

7. The stoma site (above, below and under each flange) and back of the neck should be cleaned and thoroughly dried with the water and gauze using a clean technique.

8. Thread the new tape through the flange on the side furthest away from the tape changer.

9. Tie the tapes using three knots ensuring the tape is flat to the child's skin.

10. Thread tape through near side flange, tie once and make a bow.

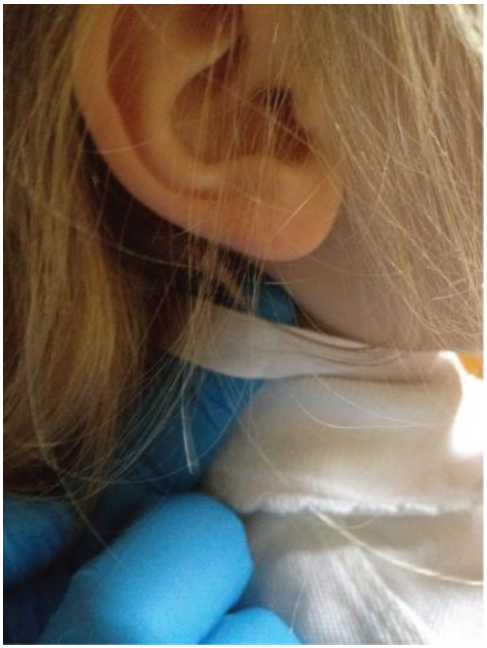
11. Check tape tension using the following methods.

i. Raise baby/child to a sitting position while assistant continues to hold tube in position.

ii. With the baby/child's head bent forward it should be possible to slip one finger comfortably between the ties and the baby/child's neck (Figure 9.11).

Figure 9.10 Positioning for a tape/tube change. Note the rolled towel under the shoulders. The tube should be supported at all times.

Figure 9.11 One finger should slip comfortably between the tapes and the child's neck.



Tape tension for tracheostomy

1. If the ties are too tight or loose, lay the baby/child back down, undo the bow and readjust.

2. If the tension is correct, lay the baby/child down and change the bow into three knots by pulling the loops of the bow through to create a second knot.

3. Tie one further knot to secure the ties.

4. Cut off excess tape to leave ½ in. remaining.

5. Assistant may release tube only when instructed to do so.

6. Record the tape change in the baby/child's healthcare records.

7. Check all equipment is replaced and restocked as necessary.

Planned (elective) tube changes

Tracheostomy tubes can be changed weekly to monthly depending on the type of tube, the maturity of the stoma and the patient. Ask the TNP or child's doctor if unsure. Only personnel trained and competent in the techniques involved must perform a tracheostomy tube change and two people are required.

An older child should not require swaddling. Some children may assist with the procedure, such as cleaning the stoma site, holding the tracheostomy tube, and so on. Some children may need to be swaddled to maintain their safety during the change (Figure 9.12); assess each child individually.

Figure 9.12 Demonstrating swaddling on an infant mannequin.

Equipment

The following equipment should be prepared.

- Emergency equipment, oxygen and suction

- A tracheostomy tube of the same size
- A tracheostomy tube a size smaller
- A water-based lubricant, such as Aqualube or KY Jelly
- Gauze swabs
- Saline sachets
- Two lengths of ¼ in. cotton tape
- Round-ended scissors
- A rolled up towel
- Gloves and an apron
- Goggles/protective eye wear
- Two syringes may be required if the child has a cuffed tube.

To change a tracheostomy tube

1. Perform a clinical hand wash.

2. Put on gloves, apron and protective eye wear.

3. Lubricate new tube with a 'dot' of water-based lubricant on the outside bend of the tube. Insert obturator into the tube.

4. Position the rolled-up towel under the child's shoulders, as per tape changes.

5. Assistant to swaddle baby, exposing shoulders and above (baby in supine position) if appropriate.

6. Place clean tapes behind the baby/child's neck.

7. Assistant should hold the tube in position using either the thumb and index finger, or index and middle finger.

8. Tube changer should cut the ties between knot and flange.

9. Remove the dirty ties.

10. Remove the tube from the stoma with a curved action.

11. Quickly insert new tube with a curved action.

12. Remove obturator.

13. The assistant should take over and hold the tube in position.

14. The stomal area and back of the neck should be cleaned and dried with the water and gauze using a clean technique.

15. The ties are then tied using the method previously described.

Remember to document any difficulties encountered and how you managed them, along with recommendations for personnel, equipment, environment and procedures for any subsequent tube changes.

Staff and carer competency guides

Most paediatric patients will be cared for by a combination of nursing staff and their parents or carers. If the child is going to leave hospital with a tracheostomy tube *in situ*, then preparation and training of the carers should commence as soon as possible. GOSH have developed the given competency documents to assist with defining which competencies are required for both carers and staff and therefore to guide training.

The following documents are available in the hyperlink given in the footnote . This ensures that the latest versions are available. The versions from 2012 are available in the Appendix to this document.

Staff and carers should be trained and assessed in the following competencies:

- Staff competency—home preparation[1]
- Staff competency—ventilated child
- Carer competency—home preparation
- Carer competency—ventilated child (Figure 9.13)

Figure 9.13 Ventilator-dependent paediatric patients with tracheostomy tubes can have complex care needs.

Emergency management of the child with a tracheostomy

Basic Life Support (BLS) for the baby or child with a tracheostomy

The basics of cardiopulmonary resuscitation (CPR) and Basic Life Support (BLS) are universal to all protocols for emergency care.

- Airway management
- Rescue breathing
- Circulatory support.

As with adult tracheostomy-related emergencies, there are often two airways to consider. However, although you are extremely unlikely to encounter a child with a laryngectomy, tracheostomies may have been performed because of a difficult or impossible to manage upper airways. This is essential information that must be communicated between medical and nursing staff at handovers, as it will influence management in an emergency.

As with adult patients, the nature and age of the stoma are important, although most stomas will be formed with an open surgical technique. Extreme care must be taken when manipulating or changing a tube that sits in a stoma that is less than 1 week old. The risks of misplacement into the soft tissues of the anterior neck are high.

The airway element of BLS will require modification in children with tracheostomies; it is therefore essential that practitioners have received training in both routine and tracheostomy BLS. The following section describes BLS for children with a tracheostomy in the community setting. Hospitalised patients will have extra equipment, infrastructure and expertise immediately available and are considered separately. BLS is similar in the sequence of skills to be performed for those with a tracheostomy:

1. Safety
2. Stimulate
3. Shout
4. Airway
5. Suction
6. Breathing
7. Circulation

Safety

If you think there is a problem with a baby or child with a tracheostomy, you must act confidently and quickly. However, make sure you are not putting yourself at risk and potentially causing two casualties. The first thing to do is to rapidly assess that it is safe for both you as the rescuer, and the child as the victim, for you to approach and touch the baby or child.

Quickly look around the area in which the baby or child is lying to make sure there are no environmental hazards—for instance, road traffic, chemical spills or electrical currents. If necessary, you must make the area safe first before you approach. Before you touch the baby or child, have a look for any clues as to what may have caused the problem—for instance, have they fallen or choked? If you have any suspicion the child's head, neck or spine could be injured, then the child should be moved only if absolutely necessary. However, remember that even if a person has a severe head or neck injury and is not breathing, death will result without BLS.

Stimulate

Try to establish whether or not the baby or child is responsive—use gentle stimulation, such as tugging the hair or pinching the child, as well as loudly calling the baby's name if you know it, or asking it to wake up.

Shout

Do not leave the baby or child but call out for assistance from another person. As you continue to deal with the child, identify a person to go to call for the emergency services. You should ask the person to phone for an ambulance, and tell the operator that a child with a tracheostomy is being resuscitated, stating the exact location. Ask the person to come back to tell you that this has been done.

If you are on your own, still call out for help but do not leave the baby or child at this stage, as it is essential you start to provide BLS.

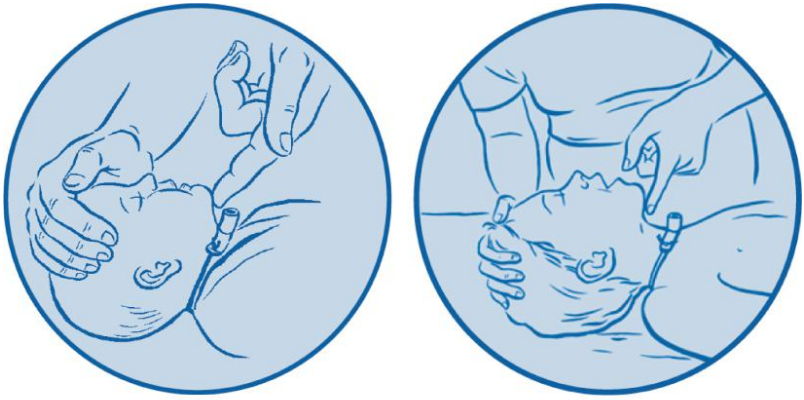
Check and open the airway

If the baby or child is unresponsive, you must make sure their airway is not blocked and that air can pass to the lungs. Make the baby or child lie on the back on a flat, firm surface and place one of your hands around the top of the head to support it. With the fingers of your other hand, gently lift the tip of the baby's or child's chin backward. This exposes the tracheostomy tube [Figure 9.14]. Take care not to press on the soft tissues underneath though, as this may block the upper airway. Any

humidification devices, HME filters or speaking valves should be removed in an emergency as they may have become blocked with blood or secretions.

Figure 9.14 Opening the airway (a) in a baby and (b) in an older child.

Reproduced with permission of GOSH.



Older children may have tracheostomy tubes *in situ*, which are large enough to accommodate a removable inner cannula. Inner tubes used with tracheostomies can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly in their design, with some requiring replacing after cleaning, to allow connection to breathing circuits. It is essential to know what equipment is used in your clinical areas, as unfamiliarity with equipment may lead to morbidity and mortality. If an inner tube is present, this should be removed at this stage (Figure 9.15).

Figure 9.15 Removing the inner tube (if present) may alleviate an obstruction.

Reproduced with permission of GOSH.

Suction

The next step is to suction the tracheostomy tube. Suctioning will clear any obstruction in the majority of cases (Figure 9.16). However, if any resistance is felt or the suction catheter is unable to pass down the tube, then the tube may be partially displaced or completely blocked. The tracheostomy tube should be changed immediately.

Figure 9.16 Suctioning the tracheostomy tube.

Reproduced with permission of GOSH.

If the stoma closes on removal of the tube and the new tube cannot be replaced, attempt to pass a smaller tube. If this is unsuccessful, thread a suction catheter through the tracheostomy tube and insert the tip into the stoma. Then attempt to guide the tracheostomy tube along the catheter and through the stoma. If this is also unsuccessful, ventilation can be attempted either via the catheter or by the nose/mouth method.

These options may not be suitable for all infants or children. The exact requirements and sequence of events will be discussed during individual training with parents or carers.

Assess breathing

Following attempt to clear the tracheostomy tube or changing it for a new tube, the next step is to assess for breathing through the airway(s). Supporting the (new) tube, place the side of your face over the tracheostomy tube to listen and feel for any breath. At the same time, look at the baby's or child's chest to observe any breathing movement. Take up to a maximum of 10 s to check for breathing (Figure 9.17).

Figure 9.17 Checking for breathing at both potential airways in a (a) younger and (b) older child.

Reproduced with permission of GOSH.

(a) (b)

If the baby or child is breathing normally—that is, more than a few occasional gasps—keep the airway open by suctioning the tube and regularly reassess the breathing as you wait for the ambulance to arrive. If you are on your own, you must secure the tracheostomy tube with your emergency strapping.

Then, either carry the baby or child with you to summon more help, or if too large to carry, turn the child onto the side into a position where the airway is kept open and the child cannot roll over. Return them as soon as you have summoned more help and reassess the child as soon as mentioned earlier. The person who demonstrates the procedure for BLS to you will discuss this in more detail, appropriate to your baby or child.

If the baby or child is not breathing, or there are only occasional infrequent gasps, you will have to provide rescue breaths for them.

Rescue breathing

With the baby or child lying on the back and the tracheostomy tube exposed, gently blow into the tracheostomy. The easiest way to do this is to put a catheter mount (from your emergency kit) on the end of the tracheostomy tube. Adapters are available from the hospital where the tracheostomy was initially performed, or from the Community Nurses.

Cover the mount with your mouth and blow until you see their chest rising (this tells you that the lungs are inflating).

Remove your mouth from the tracheostomy tube to let the breath escape from the lungs (you will see the chest fall again). Repeat this five times, at a rate of about one breath every 2 s. Breathing is adequate if you can see the chest rise and fall with each breath. After five rescue breaths, you must check to see whether oxygen is still circulating around the baby's or child's body. To do this, you must see if there are any 'signs of life'. If responders have been trained to use alternative methods of ventilation such as a self-inflating or paediatric 'Ambu© bag', then these can be used instead of 'mouth-to-trachy' ventilation (Figure 9.18).

Figure 9.18 Rescue breathing in (a) a baby and (b) an older child.

Reproduced with permission of GOSH.

Check for 'signs of life'

To check for signs of life, look at the baby or child for any breathing, swallowing or body movement. Take up to a maximum of 10 s to check. If there are none, or you are in any doubt, you must proceed to chest compressions. Assessing for 'signs of life' has replaced a pulse check for non-medically trained responders, as accurately detecting a pulse can be notoriously difficult, even to an experienced clinician.

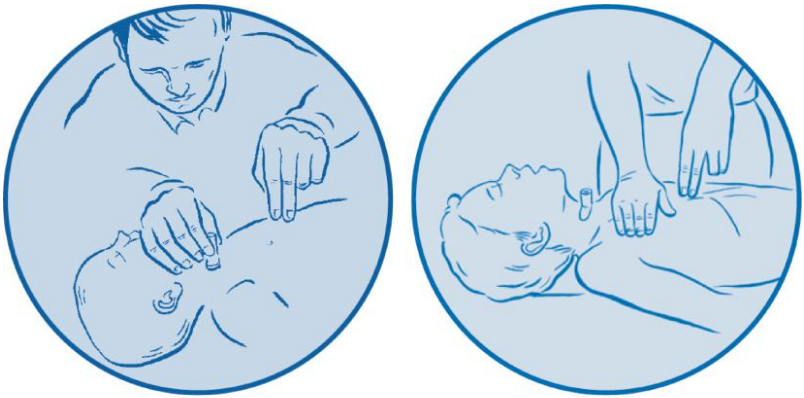
Chest compressions

External chest compressions are required when the baby's or child's own circulation is not adequate enough to circulate blood and oxygen around the body. The heart may have stopped beating or may be beating too slowly to provide an effective circulation. This will result in none of the 'signs of life' referred to earlier and requires chest compressions to start an artificial circulation. To deliver chest compressions effectively and as safely as possible, the fingers or hand(s) need to be placed over the lower part of the sternum (breastbone).

In babies (under 1 year): place two fingers approximately a finger's breadth up from the point where the ribs join the sternum [Figure 9.19(a)]. Check to see that you are not over the very end of the sternum—if you are, move your fingers further up the chest.

Figure 9.19 Hand position for chest compressions in (a) a baby (<1 year) and (b) an older child.

Reproduced with permission of GOSH.



In children above 1 year: place the heel of one hand approximately a finger's breadth up from the point where the ribs join onto the sternum [Figure 9.19(b)]. Again, check to see that you are not over the very end of the sternum—if you are, move the heel of your hand further up the chest. Use your body weight to depress the sternum by one-third of the chest

diameter. If it is difficult to achieve this depth, both hands (one on top of the other) may be needed.

In all cases, the chest should be depressed 15 times. Each depression (compression) should be a smooth, non-jerky manoeuvre that spends equal time in the depression (compression) and the relaxation phase. The fingers or hand(s) should not be removed from the chest wall until the cycle of 15 is complete. Chest compressions should be delivered at a rate of approximately 100 times per minute.

Combining rescue breaths and chest compressions

Once you have started chest compressions, they need to be interspersed with rescue breaths. It is recommended that in babies and children, two breaths should be delivered between each cycle of 15 compressions. This sequence of 15 to 2 should be continued for approximately 1 full minute before you reassess the situation.

Ongoing resuscitation

After 1 min of BLS, you should stop and reassess the baby or child for any spontaneous breathing and signs of life in the same manner as before. If there are none, then you must continue your attempts at resuscitation.

In addition, at this time you must check whether help is on the way. If someone has already been asked to summon more help, you must confirm that this is coming. If there is any doubt that more help has been summoned, then you must now do this yourself. You may have to make a decision as to whether or not you can safely carry the baby or child with you to summon more help. If it is not possible to do this safely, then you must leave the child and summon more assistance. Return as quickly as possible, and resume BLS as before.

Once started, BLS should be continued until:

- there are any ‘signs of life’ from the baby or child (which means you need to reassess them and decide if BLS is still needed)
- trained healthcare personnel take over from you
- you are too exhausted to continue.

Further training for carers

You never know when these vital life-saving skills may be necessary. It might not even be for your own child, but that of a friend, neighbour or complete stranger who could be dependent on someone like yourself having learned and rehearsed these techniques. Unfortunately, however, there are some tragic occasions when despite the best efforts of yourself, ambulance and hospital personnel, some babies and children will not respond to resuscitation attempts. However, by learning these essential skills and revising them regularly, you will give babies and children the best possible chance of survival.

These instructions are available in a printable guide via the GOSH website (www.GOSH.nhs.uk tracheostomy pages) or directly from the link later. Carers should read these instructions regularly to refresh their memory. Try to imagine an emergency before it arises so that you can anticipate what you would do in that situation. It is also worth ensuring other family members and friends know how to summon emergency help and encourage them to formally learn BLS skills also.

Emergency care and BLS can be learnt by enrolling on a St John Ambulance or other recognised first aid course.

Link to Tracheostomy BLS guide in PDF format (http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=81820)

Useful numbers

At GOSH: St John Ambulance National HQ:

Resuscitation service 27, St John's Lane

020 7813 8197 London EC$_1$M $_4$BU

020 7829 7854 08700 10 49 50

Tracheostomy Nurse Specialist

020 7405 9200 bleep 0712

www.sja.org.uk

Advanced Life Support (ALS) for the baby or child with a tracheostomy

The principles of BLS, as described in the previous section, can be applied in the hospital setting. There are differences in the patient case mix, infrastructure, equipment and personnel available to manage an emergency when comparing similar situations that may occur in the community. Hospitalised patients are more likely to have acute medical or surgical problems and therefore be more prone to rapid deterioration. The tracheostomy itself may be relatively new, which may have implications for emergency management. However, there is also access to advanced resuscitation equipment, oxygen, capnography and trained airway experts in hospitals to assist with managing these emergencies.

When applied to a patient with a tracheostomy, CPR may be more difficult to teach and to learn because additional processes are required to determine and correct the cause of the collapse. The airway element of BLS will require modification in children with tracheostomies, it is therefore essential that practitioners have received training in both routine and tracheostomy BLS. The following section describes ALS for children with a tracheostomy in the hospital setting and should be read in conjunction with the previous section which is aimed primarily at non-medically trained carers. BLS is similar in the sequence of skills to be performed for those with a tracheostomy:

1. Safety

2. Stimulate

3. Shout
4. Airway
5. Suction
6. Breathing
7. Circulation

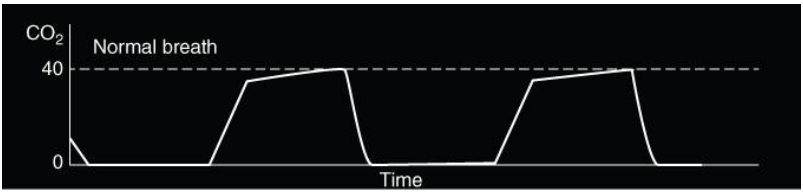
Initial response

Ensure safety of yourself and the child. Stimulate the child and call their name, taking care to support the head and body.

Calling for assistance is essential in the hospital environment. If there is any doubt about the clinical condition of the child, summon the hospital's paediatric emergency or cardiac arrest team. You will also need a senior clinician with expertise in tracheostomy management. Who this is will depend on your hospital and the infrastructure within it. Senior nursing staff, tracheostomy specialist nurses, head and neck surgical team members, anaesthetists or intensivists may all be suitable to be called in an emergency. There should be systems in your hospital to do this quickly, with contingency plans if an individual or team is unavailable (usually a cascade bleep system or similar mechanism).

In addition to personnel, emergency equipment is required. Most of this should be checked and ready at the bedside, but additional oxygen supplies, capnography and anaesthetic breathing circuits may need to be brought from the ward or unit's resuscitation (crash) trolley, along with additional monitoring, for example, for pulse oximetry, electrocardiogram (ECG) and blood pressure. If a tracheostomy tube has become displaced, or the stoma or airway is known to be difficult to manage, an appropriate fibreoptic endoscope should be summoned. This should be immediately available in clinical areas where tracheostomies are routinely managed [ENT wards or paediatric intensive care units (PICUs)] and other areas should know where to find a scope in an emergency (Figure 9.20).

Figure 9.20 Waveform capnography is invaluable when managing airways and should be available.



If you are by yourself, do not leave the patient at this stage. Open and check the child's airway by placing supine on a flat firm surface. It may be helpful to put a folded towel under the shoulders, only if this is immediately available. Do not waste time by collecting towels. Gently tilt the tip of the chin upward, taking care not to press on the soft tissue underneath.

Any humidification devices, HME filters or speaking valves should be removed in an emergency as they may have become blocked with blood or secretions. Inspect tube for obvious problems or signs of blockage: crusts, kinks or dislodgement.

Older children may have tracheostomy tubes *in situ*, which are large enough to accommodate a removable inner cannula. Inner tubes used with tracheostomies can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly in their design, with some requiring replacing after cleaning, to allow connection to breathing circuits. It is essential to know what equipment is used in your clinical areas, as unfamiliarity with equipment may lead to morbidity and mortality. If an inner tube is present, this should be removed at this stage (Figure 9.21).

Figure 9.21 Removing the inner tube (if present) may alleviate an obstruction.

Reproduced with permission of GOSH.

Assessing tracheostomy patency

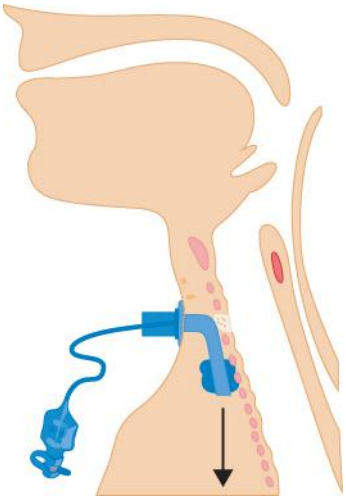
The next step is to suction the tracheostomy tube. Suctioning will clear any obstruction in the majority of cases. However, if any resistance is felt or the suction catheter is unable to pass down the tube, then the tube may be partially displaced or completely blocked. The tracheostomy tube should be changed immediately. If the stoma is less than 1 week old, then the risks of inserting a new tube into a false passage in the soft tissues of the neck are increased, along with trauma and bleeding. Misplacement of a tube into a false passage does not secure the airway (Figure 9.23).

Figure 9.22 Suctioning the tracheostomy tube.

Reproduced with permission of GOSH.

Figure 9.23 Tube insertion into a false passage in the soft tissues of the neck.

Reproduced with permission of HEE eLfH.



When changing a tube, the same size tube should be inserted. If you are unable to insert the same size tube, try to insert the one that is a size smaller. If the stoma closes on removal of the tube and the new tube

cannot be replaced, attempt to pass a smaller tube. If this is unsuccessful, thread a suction catheter through the tracheostomy tube and insert the tip into the stoma. Then attempt to guide the tracheostomy tube along the catheter and through the stoma. The Seldinger technique should be practiced as a first-line attempt at reinserting a tracheostomy tube. Tracheal dilators should only be used by practitioners experienced in their use. If tube reinsertion is unsuccessful, ventilation can be attempted either via the catheter or by conventional rescue breaths (e.g. mouth-to-mouth or bag and mask over the mouth and nose). Supplemental oxygen should be applied as soon as it is available.

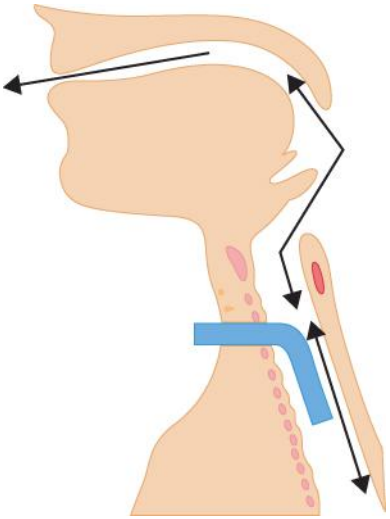
It is important not to attempt high-pressure ventilation via a tracheostomy tube that appears blocked or displaced (suction catheter won't pass, absent capnography trace). If the tube has become displaced into the soft tissues of the neck, rapid surgical emphysema can develop and even a small amount of gas in the tissues can make managing a paediatric stoma or airway difficult or impossible.

All options may not be suitable for all infants or children, especially those with abnormal upper airway anatomy. The exact requirements and sequence of events will be discussed and agreed when the patient first presents. Airway alert or tracheostomy bedhead signs can be extremely useful in these circumstances to inform emergency responders of underlying disease or anatomy.

If the patient has a patent upper airway, breathing around the tracheostomy tube may be possible, even if it is blocked or displaced. If there is any evidence of breathing via the upper airways, then oxygen should be applied via a conventional facemask (Figure 9.24).

Figure 9.24 Airflow may be possible around the tube.

Reproduced with permission of HEE eLfH.



Primary emergency oxygenation

Following airway opening manoeuvres (native upper airway and attempting to suction or change the tracheostomy tube), the next step is to reassess whether the interventions have improved the situation. This assessment is primarily a clinical one, but is supported by appropriate monitoring, such as pulse oximetry and capnography.

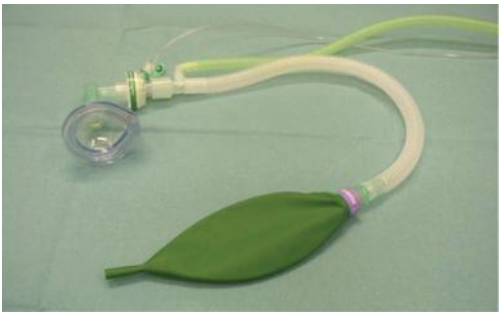
Look, listen and feel for any breathing at both the upper airway (nose and mouth) and the tracheostomy tube, or open stoma if a new tube could not be re-inserted. At the same time look at the child's chest to observe any breathing movement. Take up to a maximum of 10 s to do this.

If the child is breathing adequately, give oxygen and keep the airway open by regular suction and wait for the clinical emergency team.

If the child is not breathing (or only making agonal gasps), then emergency oxygenation is required. The priority is to oxygenate the child, not necessarily to reinsert a new tracheostomy tube or oral/nasal endotracheal tube, although these more invasive methods may be required if simpler measures are unsuccessful.

If the tracheostomy tube is patent, commence artificial respiration with a bag-valve system directly connected to the tracheostomy tube and administer five breaths. This is best achieved with a 15 mm swivel connector attached to a self-inflating bag (e.g. Ambu bag) or paediatric anaesthetic breathing circuit (Figure 9.25 shows a Mapleson F circuit). Remember to attach oxygen and capnography as soon as they are available. Oxygen should be set at a minimum of 10 l/min for a paediatric system (usually weight under 20 kg) and 15 l/min for the adult system (appropriate for weights over 20 kg). Ensure that the breaths are effective by observing chest movement and an appropriate waveform on the capnography display.

Figure 9.25 A Mapleson F circuit, commonly known as Jackson-Rees' modification of the Ayre's T-piece.



Standard oral airway manoeuvres include the use of oral or nasal adjuncts (Guedel airways, nasopharyngeal airways) or supraglottic airway devices such as the LMA (Figure 9.26). If the tracheostomy stoma is open (without a tube) and the patient is being ventilated via the upper airways, the stoma may need to be covered to allow effective delivery of the gas to the lungs.

Figure 9.26 Laryngeal mask airways.

Ventilation can also be achieved by delivering oxygen via the open stoma. Suitable techniques include a small, paediatric facemask (Figure 9.27), or an LMA applied to the skin.

Figure 9.27 Selection of facemasks.

Secondary emergency oxygenation

If the less invasive methods of oxygenation fail, then insertion of an airway device is required. This can either be via the upper airways (oral or nasal intubation) or via the tracheostomy stoma. The choice of route depends on several factors.

- The age of the tracheostomy stoma. A stoma that is less than 1 week old will be more difficult to cannulate with increased risks of misplacement. The stoma may also close on removal of a tube.
- The presence of stay sutures. These may assist reinsertion of a tube into the stoma, making this the easier airway to manage.
- If the patient has a known difficult (or sometimes impossible) to manage upper airway. The stoma becomes the easier airway in this circumstance. It may still be possible to oxygenate to some degree via the upper airway.
- The expertise and experience of the attending emergency team. If your expertise is managing upper airways (usually anaesthetic backgrounds), then don't change what you do normally in an emergency. Likewise if you are more comfortable manipulating tracheostomy tubes and managing stomas (usually head and neck surgical backgrounds).
- The equipment that is immediately available. All difficult airway equipment including a range of laryngoscopes, bougies, introducers and a suitable fibreoptic endoscope should be available for tracheostomy emergencies. Emergency anaesthetic and resuscitation drugs may also be rapidly required.
- The location. Sometimes it is better to wait until the patient is in a safe location for airway management before attempting invasive airway manoeuvres. The risks of transferring a patient will need to be balanced by the attending clinical teams. If a patient's oxygenation can be adequately maintained, it is often safer to assemble the personnel, equipment and any required drugs in a critical care or theatre area to optimise the chances of successful difficult airway management.

Discharge from hospital with a paediatric tracheostomy

Consideration of discharge planning should start as soon as the decision to perform a tracheostomy is taken. Consideration needs to be given to who will provide care, where and how the child with a tracheostomy will be

managed following discharge. This can be straightforward in the case of a well-supported child, but the complex interactions between primary and secondary care mean that planning and communication are essential to facilitate the smooth transfer of safe care (Figures 9.28 and 9.29).

Figure 9.28 New tracheostomy flow chart © 2009 Great Ormond Street Hospital for Children NHS Trust, London, UK.

Reproduced with permission of GOSH.

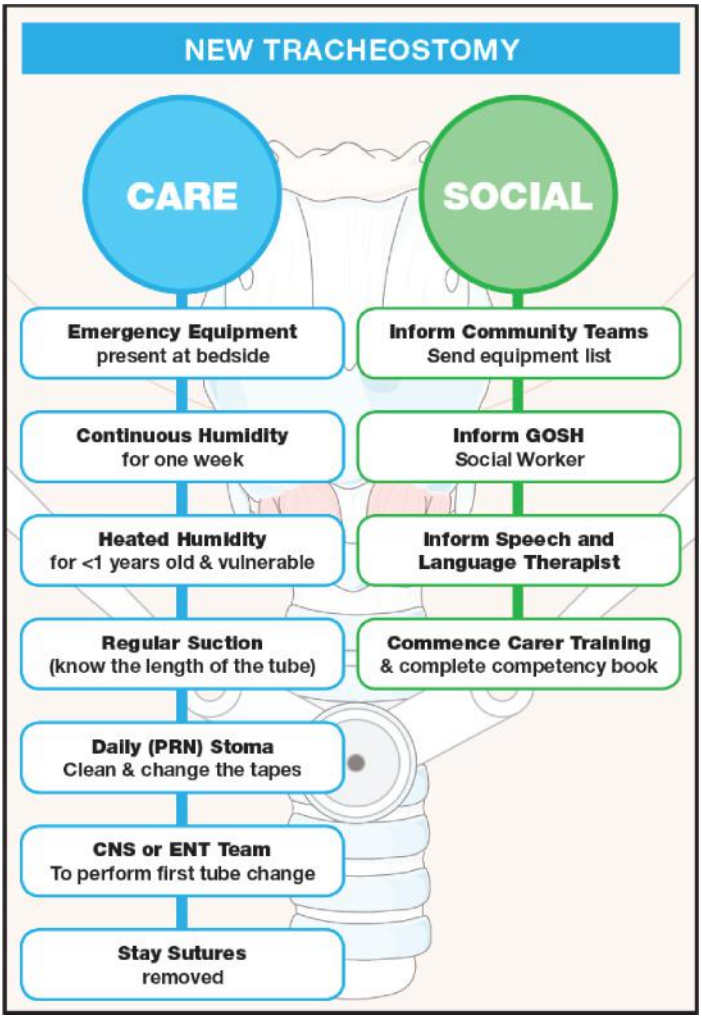
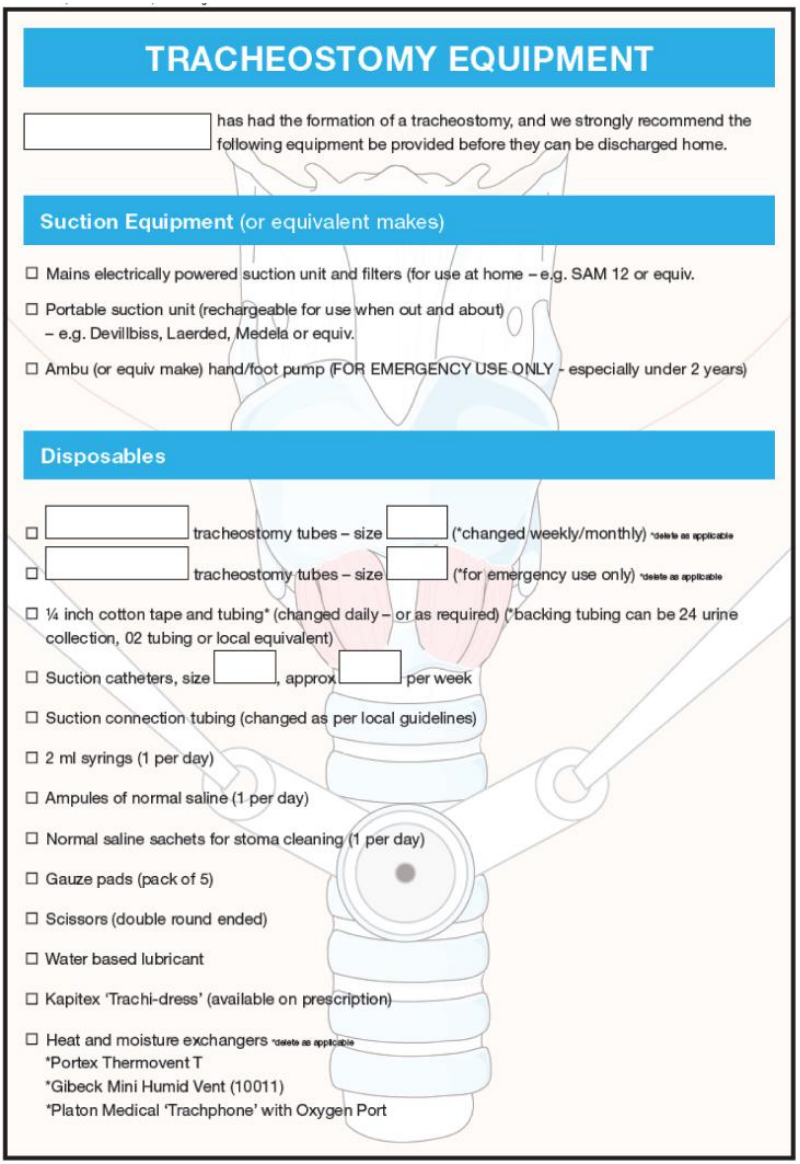


Figure 9.29 Tracheostomy equipment checklist © 2009 Great Ormond Street Hospital for Children NHS Trust, London, UK.

Reproduced with permission of GOSH.



TRACHEOSTOMY EQUIPMENT

[ ] has had the formation of a tracheostomy, and we strongly recommend the following equipment be provided before they can be discharged home.

Suction Equipment (or equivalent makes)

- ☐ Mains electrically powered suction unit and filters (for use at home – e.g. SAM 12 or equiv.
- ☐ Portable suction unit (rechargeable for use when out and about) – e.g. Devillbiss, Laerded, Medela or equiv.
- ☐ Ambu (or equiv make) hand/foot pump (FOR EMERGENCY USE ONLY - especially under 2 years)

Disposables

- ☐ [ ] tracheostomy tubes – size [ ] (*changed weekly/monthly) *delete as applicable
- ☐ [ ] tracheostomy tubes – size [ ] (*for emergency use only) *delete as applicable
- ☐ ¼ inch cotton tape and tubing* (changed daily – or as required) (*backing tubing can be 24 urine collection, 02 tubing or local equivalent)
- ☐ Suction catheters, size [ ], approx [ ] per week
- ☐ Suction connection tubing (changed as per local guidelines)
- ☐ 2 ml syringes (1 per day)
- ☐ Ampules of normal saline (1 per day)
- ☐ Normal saline sachets for stoma cleaning (1 per day)
- ☐ Gauze pads (pack of 5)
- ☐ Scissors (double round ended)
- ☐ Water based lubricant
- ☐ Kapitex 'Trachi-dress' (available on prescription)
- ☐ Heat and moisture exchangers *delete as applicable
  *Portex Thermovent T
  *Gibeck Mini Humid Vent (10011)
  *Platon Medical 'Trachphone' with Oxygen Port

The community team should be contacted after 1 week to confirm tube style/size, which may have had to be changed during the first week. The

progress of supply orders should also be checked. Discussion of respite and carer support should be broached with the community team. Most children will be discharged back via their local hospital, which will allow local services and support to be activated. Negotiations to do this should begin as soon as the tracheostomy is formed.

The formation of a tracheostomy must be confirmed (usually by telephone) with the child's:

- Health Visitor (HV)
- General Practitioner (GP)
- Paediatric Community Nurse (PCN)
- school (including school nurse if applicable)
- local hospital.

This should occur as soon as practical following the insertion of the tracheostomy. An equipment list and introductory letter should be sent so that equipment can be ordered, minimising potential delays on discharge from hospital.

However, some children, such as those who have had a planned tracheostomy or who have been in hospital for a long time, may be discharged home straight from a tertiary hospital. Some equipment may have to be provided to facilitate this, which should be discussed individually with the communities involved. Ensure that the portable suction unit has been collected from the community team before the day of discharge, brought to the hospital for the transfer home and the parents are aware of how it works.

The child's parents, or two main carers, must be taught and be deemed as competent in the following:

- tracheostomy tube changes (minimum of two)
- tracheostomy tape changes
- stoma care
- suctioning
- resuscitation skills/emergency care
- staying and doing an overnight stay with the child and carry out all care overnight
- feeling confident in taking the child out of the hospital.

Sometimes it is not possible to complete all the training at the primary hospital and local teams may have to complete some elements of the training. This should be explicitly communicated. Tracheostomy care and resuscitation booklets are available to support carer training. The GOSH booklets are available from the GOSH website, with the links available at the end of this chapter. All training received must be recorded on the child's discharge planner and kept in their health record for future reference.

Parents and carers will need to be taught tracheostomy BLS and 'mouth-to-trachy' resuscitation for going home. In addition to the other equipment required, they must be given a catheter mount 15 mm female, and two emergency Velcro tapes. Community teams will usually supply the equipment for the child's discharge home. Depending on the type of tube inserted, other relevant emergency equipment may include:

- two pairs of Velcro tapes
- two disconnection wedges
- two tracheostomy extensions +/− male-to-female adapters

Parents require both theoretical and practical teaching/practice of both emergency algorithms, namely, action to take on a blocked tube and action to take if the tracheostomy tube cannot be replaced (Seldinger technique).

Follow-up

Follow-up is very important for children with tracheostomies. Practices do vary, however, and there are often local influences on the decision. Commonly, an 8-week ENT outpatient appointment will be arranged prior to discharge (unless indicated otherwise by the medical team). Although community teams will usually supply the equipment for the child's discharge home, it is important that parents and carers have the correct emergency equipment (and knowledge of how to use it) for as soon as the patient leaves hospital. This starts as soon as the child leaves the ward and includes the journey home.

Further information

General Information

GOSH general information guide (http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=80519): Covering indications, tubes and humidification

GOSH 'TRACHE' poster (Figure 9.30)

Figure 9.30 GOSH 'TRACHE' poster.

Reproduced with permission of GOSH.

T — **Tapes - Keep tube secure**

Ensure the tension of the tapes is tight enough to support the tube One finger should fit comfortably between the child's neck and the tapes.

R — **Resus - Know the resuscitation process**

- Safety, Stimulate, Shout for help
- SUCTION airway- if the tube is difficult to suction or is blocked, change the tube, suction again,
- Check for breathing. If required, use the self-inflating bag ventilation device with the Portex swivel connector to give rescue breaths, then follow BLS algorithm for circulation.

A — **Airway clear - Use correct suction technique**

Use correct catheter size and length of suctioning. Know the length of the child's tube and only suction just beyond it, i.e. To allow the lateral and distal holes beyond the tube tip. The catheter size should be 'double the size of the tube'. For example 8 FG catheter for a 4.0 ID tube.

C — **Care of the site - Stoma and neck**

Trache site should be cleaned at least daily and any breakdown noted and treated. Don't forget the back of the neck!

H — **Humidity - Essential to keep tube clear**

Must use either the water system or an HME. If it is the water system no more than 6 sections of tubing and check that water droplets are present throughout the tubing. Use warmed humidity systems for small babies who are at risk of heat loss. Use the Correct size Heat and Moisture Exchanger (HME- Swedish Nose).

E — **Emergency box - Have the box present**

Emergency box should only contain the correct equipment. Equipment list is inside the lid of the box. No other items should be present.

GOSH pdf guides and leaflets

- Staff competency—home preparation
- Staff competency—ventilated child[2]
- Carer competency—home preparation[3]
- Carer competency—ventilated child[4]
- GOSH BLS guide for parents and carers—BLS guide[5]
- New tracheostomy discharge algorithm[6]
- New tracheostomy equipment form[7]

Information for parents of a child with new tracheostomy

- Living with a tracheostomy[8]—GOSH webpage
- Living with a tracheostomy[9]—pdf leaflet

[1] http://www.gosh.nhs.uk/health-professionals/clinical-guidelines/tracheostomy-care-and-management-review/

[2] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=80518

[3] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=80516

[4] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=80514

[5] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=81820

[6] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=80513

[7] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=80512

[8] http://www.gosh.nhs.uk/medical-conditions/procedures-and-treatments/living-with-a-tracheostomy/

[9] http://www.gosh.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=81821

Chapter 10

Infrastructure considerations

Introduction

In order to safely care for patients with tracheostomies in our hospitals, we need to address the organisation and infrastructure of the clinical areas where patients with tracheostomies and laryngectomies will be managed. This is important outside the hospital in community organisations and the homes of patients.

As part of this project, we have been able to look at policies and documentation of many Trusts. We have also been able to view detailed reports from coronial inquests and serious untoward incident reviews, which have helped to inform the following pages.

This section includes guidance regarding infrastructure and resources for hospital inpatient areas, an example tracheostomy policy and risk assessment. Competencies for tracheostomy care and management are presented in Chapter 11.

Hospital inpatient management

Any clinical area can potentially look after neck-breathing patients, but these areas must be:

- adequately staffed
- adequately trained
- adequately equipped
- adequately supported.

In order to do this effectively, most Trusts will have to cohort patients with tracheostomies together into designated wards. This allows training

and equipment to be targeted and concentrates expertise and experience. Nominated areas would typically include:

- critical care areas
- head and neck wards
- designated respiratory/medical/surgical wards.

Patients with tracheostomies or laryngectomies should not be cared for outside these areas. This has implications for the flow of patients into, out of and around a hospital, and the bed managers will need to be adequately involved in planning patient movement. Patients can also come directly from the community or through the emergency department.

Given here are the key areas to consider for those designated wards.

1. Competency and training

a. Staff must have received documented training appropriate to their duties.

b. Staff must have knowledge of where to find additional resources (some of the resources presented as part of this project could be considered 'just-in-time' training).

c. Staff must know who to call and what to do in an emergency.

2. Equipment provision

a. Wards must be stocked with airway- and tracheostomy-specific equipment.

b. Only suitable tubes should be used in non-specialist locations (uncuffed, inner cannula).

c. There must be immediate access to a fibreoptic endoscope.

d. Bedside emergency equipment must be available at all times and accompany the patients if they move around the hospital.

e. Equipment must be checked and a means of documenting this must be in place.

3. Staffing numbers

a. Extra staff may be required if the dependency of a tracheostomy patient requires it.

b. Consideration of one-to-one nursing/nursing auxiliary on initial step-down from a higher level of care for 24–48 h.

4. Discharge planning

a. Multi-disciplinary

b. Documented.

5. Follow-up

a. Patients who have had a tracheostomy should be followed up by a clinical team able to:

i. assess for long-term complications;

ii. diagnose and either treat such complications, or have access to appropriate services.

b. Follow-up should be offered to patients who have been decannulated and those in whom a tracheostomy tube remains *in situ*.

c. Patients with long-term tracheostomies should also undergo periodic review by a team able to assess and manage potential long-term complications, and able to assess the ongoing need for the tracheostomy to remain.

d. Medical and multi-disciplinary follow-up arrangement must be clear and documented.

6. Documentation

With regard to inter-hospital transfer between acute hospital sites, it is the responsibility of the transferring/discharging hospitals/units to ensure that the patient transfer is communicated to the relevant team(s) within the receiving Trust. Adult patients with tracheostomies should only be transferred to hospital sites where there is appropriate arrangement in place to adequately care for the patient's needs.

Draft tracheostomy policy outline

The policy detailed here is an example based on amalgamated policies from several hospitals in the North West Region of England. Clearly, hospital policies will vary, but this is included to give the reader a framework if you were considering writing your own tracheostomy policy. It may be useful to designate specialist areas (ICU; HDU, high-dependency unit or a head and neck unit), non-specialist areas

(nominated, trained, adequately staffed and equipped to care for patients with tracheostomies) and then all other clinical areas.

Duties within the organisation

Chief Executive

The Chief Executive is responsible for ensuring the requirements within this policy are fulfilled and operational responsibilities are in place when patients who are 'neck breathers' are nursed on general wards.

Chief Nurse

The Chief Nurse is responsible for ensuring requirements within this policy are fulfilled and that this policy is disseminated to all Heads of Nursing for appropriate action.

Executive Medical Director

The Medical Director is responsible for ensuring that this policy is disseminated to Consultants who supervise medical staff in training and that education and training facilities are available to ensure medical staff can maintain the level of clinical standards to appropriately manage patients who trigger on the Modified Early Warning Score (MEWS).

General Managers

The General Managers will ensure that adequate resources are available within their divisions to make provisions within this policy feasible.

Consultant (or lead clinician)

The Consultant is the professional with the overall clinical responsibility for patients, and therefore will ensure patients cared for in a designated area other than their allocated ward will receive a daily visit from a

member of the team. The Consultant will ensure that clinical standards are maintained and that any necessary deviation from this policy is documented and explained in the medical notes.

Heads of Nursing

Heads of Nursing have a responsibility to ensure that this policy is disseminated to Matrons and Ward Managers to inform clinical staff of their responsibilities in the safe care of patients who are neck breathers. In collaboration with Matrons and Ward Managers, Heads of Nursing must ensure that adverse clinical incidents in relation to the care of patients who are neck breathers in their clinical areas are reported and investigated and action plans produced to prevent future occurrence.

Matrons and Ward Managers

Matrons and Ward Managers have a responsibility to ensure that any staff responsible for caring for patients who are neck breathers receive training on their care and management and recognise when to escalate care to the appropriate people. Matrons and Ward Managers have a responsibility to ensure that all clinical staff have access to equipment and documents for providing safe care for patients who are neck breathers.

Bed Managers

Bed Managers must ensure that patients with a tracheostomy/ laryngectomy admitted to a general ward from a critical care area, specialised ward or from any community setting must be cared for in the designated areas. These areas will be identified following a Trust-wide consultation process.

Critical Care/Specialist Ward clinical staff

Most patients with a tracheostomy discharged from a specialist ward should have an uncuffed tracheostomy tube with an inner cannula sited. Exceptions to this must be clearly justified (reduced conscious level, excessive secretions, inability to protect the airway). Standardising or

limiting the different types of tubes available may make teaching easier and reduce potential confusion with tubes. At least 24 h notice should be given to the receiving ward when a patient is being discharged from a specialist area. This will ensure the receiving ward can make all necessary preparations to safely accept responsibility for the patient with a tracheostomy.

A tracheostomy Care Plan will be completed by the discharging team, and be communicated to the receiving ward nurse and agreed on before the patient is discharged from the Critical Care/Specialist Ward. This will ensure that a full handover of care is given and the receiving ward can maintain a safe environment for the patient with a tracheostomy. A risk assessment should be completed and agreed on with the receiving ward. Any problems with the tracheostomy should be clearly communicated (see draft risk assessment).

Receiving ward clinical staff

The receiving ward should ensure that the patient with a tracheostomy/ laryngectomy is nursed in a bed that is observable from the nursing station and, wherever possible, not in a side room. As a general rule, the patient should be nursed in an open observation area, rather than a side room (unless continuous 1 : 1 staffing is provided). Discussion with infection control teams should take place, as close observation for airway compromise is likely to take priority over use of a side room for infection control purposes. The receiving ward should ensure that patients with a tracheostomy/laryngectomy must have access to a nurse call bell and other communication aids, if they are able to use them.

If patients do not have adequate means of communication because of their clinical state, then adequate provision for one-to-one care must be adopted. The receiving ward should ensure that patients with a tracheostomy or laryngectomy requiring oxygen must have an oxygen supply and suction equipment at the bedside, and that the oxygen is prescribed on their prescription chart. Any patient with a tracheostomy/ laryngectomy who is oxygen dependent should have their oxygen warmed and humidified. The receiving ward should ensure that the patient with a tracheostomy has the emergency airway box at the patient's bedside at all times. The appropriate bedhead sign should be completed describing the

details of the tracheostomy. This form will be completed by the person performing the tracheostomy or by a competent member of staff if a patient is admitted to the Trust with an existing tracheostomy.

Patients with a tracheostomy/laryngectomy must have regular checks carried out as per the tracheostomy/laryngectomy Care Plan and patient bedside checklist. The receiving ward should ensure that the patient with a tracheostomy/laryngectomy has been referred to the Physiotherapy and Speech & Language teams if appropriate.

Critical Care Outreach Team

Some hospitals have 'Outreach Teams' who are well placed to support and assist ward staff with caring for neck-breathing patients and often play a vital educational role. Systems need to be in place to notify Outreach Teams if a neck-breathing patient is admitted or transferred.

Emergency teams

Any patient with a tracheostomy or laryngectomy who develops breathing difficulties or displays any of the 'Tracheostomy Red Flags' need prompt assessment by someone trained to do so. For tracheostomy/laryngectomy problems (or where clinical deterioration may be related to the airway) the patient must be seen by the ENT or MaxFax team (for ENT or MaxFax patients), or by the relevant medical team, within 30 min. Contact details are displayed on the appropriate bedhead signs. For an emergency related to the airway, decide in advance who should be called (depending on your hospital setup)

Hospital Incident Reporting System (HIRS)

Most hospitals have a system for recording adverse events and facilitating subsequent investigation. If a patient's care is affected by a failure to provide appropriate infrastructure or not following a local policy, then the Hospital Incident Reporting System (HIRS) system is a useful way of recording this and improving the systems.

Standards and key performance indicators and process for monitoring compliance

The following standards and key performance indicators could be used for monitoring compliance to a tracheostomy policy, monitored via audit.

- The Critical Care Outreach Team (or similar) have been informed of any patient nursed on a general ward within the Trust with a tracheostomy or laryngectomy.
- A tracheostomy/laryngectomy Discharge Plan has been completed for patients discharged from a specialist area.
- The patient is cared for in a designated area.
- The designated area has been given 24 h notice before the patient has been admitted from a specialist area.
- Any patient with a tracheostomy tube will have an uncuffed double-cannulae tube sited (if appropriate).
- Time of discharge from a specialist area is not between 22.00 and 07.00.
- A tracheostomy/laryngectomy Care Plan is in use and completed correctly.
- An emergency airway box is always at the patient's bedside.
- Emergency algorithms are displayed above the patient's bed where appropriate.
- Suction equipment is connected correctly and working.
- An oxygen supply is available at the bedside.
- other emergency equipment is available on the ward
- The patient is nursed in a bed that is easily observable to nursing staff.
- If administering oxygen via a stoma it is humidified.
- A referral is made to physiotherapy for a daily and weekend visit.
- An adequate supply of all necessary equipment is available on the receiving ward.

Dissemination, implementation and access to this document

All staff working on a receiving ward will receive documented training and education on the care of the patient with a tracheostomy or laryngectomy on a regular basis.

Risk assessment

The following risk factors must be taken into consideration when determining an appropriate clinical environment for a patient with a tracheostomy.

- Patient discharged from critical care within last 48 h
- Tracheostomy less than 7 days old
- Patients requiring a single-lumen tracheostomy tube for clinical reasons
- Patient known to have a complex airway and/or difficult endotracheal intubation or tube insertion (bedhead sign)
- Patients unable to call for help (including unable to use call system)
- Patients at risk of self-decannulation:
    - Delirious
    - Agitated
- Patients with an obstructed upper airway (dependent on their tracheostomy for breathing) or dependent on ventilatory support.

Any of these factors place the patient at a greater risk of airway obstruction, requiring more frequent observation by trained and competent staff and greater visibility at all times. These should form the principles that should be determined by the lead clinician for the risk assessment for the patient.

Care plans

The tracheostomy care pathway will vary from Trust to Trust. We have again viewed many excellent local examples and provided a summary that you may wish to consider for reference if updating your own pathways.

Any care pathway should be used in conjunction with the bedhead sign, detailing essential details about the tracheostomy, including any major incidents, such as decannulation, tube obstruction, and so on. An example care plan is shown in Figure 10.1.

Figure 10.1 Draft care plan.

Intensive Care Society (2008). Reproduced with permission from the UK Intensive Care Society.

Appendix 3

TRACHEOSTOMY CARE **Patient addressograph**

WARD BASED APPRAISAL OF NEED

DATE OF TRACHEOSTOMY:

TUBE TYPE: **SIZE:** **FENESTRATED: Y/N**

(Y = YES, N = NO, √ = satisfactory, CFC = cause for concern)

DATE:					
PREVIOUS TUBE CHANGE ?Problems-Y/N					
GCS					
CPAP DEPENDENT Y/N					
O_2 DEPENDENT % FiO2					
BREATHING RATE/PATTERN					
Speaking Valve Y/N how long?					
Occlusion Cap Y/N how long?					
AIRWAY VOICE Strong/Weak?					
SWALLOW assessment?					
COUGH Strong/Weak/into mouth?					
SECRETIONS ?Sticky/infected					
SUCTION No./24 HRS					
EXCESS DEMAND?e.g. Anaemic/pyrexial/ LV Function					
? Abdominal Distension					
FAILED Decannulation?					
WEANABLE ?Cuff Deflated					
Formal SALT assessment?					
DOCTOR /PHYSIOTHERAPIST:					

The pathway should include the following:

- Record of tracheostomy tube insertion and changes (and how easy/hard these were)

- Tracheostomy equipment checklist
- Tracheostomy weaning plan
- Daily care record.

We have reviewed several coronial inquests and serious untoward incident investigations regarding tracheostomy or laryngectomy care. It is useful to consider any documentation from the point of view of an external agency trying to establish the following facts after an event.

- When was the tracheostomy suctioned?
- Was the inner tube changed today?

Your documentation should make this easy to record and establish. The daily care record should therefore include the following aspects.

- Type of tube inserted
- Cuff up/down? Speaking valves?
- Inner tube cleaning
- Suction performed
- Humidification
- Oxygen
- Stoma care/dressing
- Securing the tube
- Nutrition/hydration.

It should also be easy to locate tracheostomy-specific documentation and instructions relating to the following points.

- SALT/swallowing assessment/instruction
- Plans for cuff deflation/downsizing/decannulation
- Physiotherapy plans
- Risk assessments (which may alter during the course of the inpatient stay).

Chapter 11

Competencies for staff caring for patients with tracheostomies or laryngectomies

The following document has been adapted from the NTSP resources and is used at Central Manchester NHS Foundation Trust (FT). The document is reproduced here with permission. Other documents are available from the NTSP website www.tracheostomy.org.uk.

Tracheostomy care: competency assessment criteria

COMPETENCY STATEMENT Demonstrates safe practice for patients requiring a tracheostomy and dealing with tracheostomy emergencies	
Key skills	**Assessment criteria**
1. Demonstrates an understanding of the anatomy and physiology of the respiratory system	Identify the main structures of the respiratory system Discuss the position of these structures in relation to their function Discuss the mechanics of respiration Discuss the process of oxygen delivery
2. Describes indications for tracheostomy	Identify reasons for the insertion of a tracheostomy tube Discuss the benefits to the patient Discuss the different techniques used for tracheostomy insertion Describe the investigations that are required prior to insertion
3. Demonstrates and discusses choice of tube	Identify the different tubes available and the reason for the choice of tube Discuss the principles of cuff safety

4. Demonstrates the ability to assist with insertion and can discuss potential complications	Preparation and explanation to the patient as required Discuss issue of consent Assemble the correct equipment and perform safety checks prior to procedure Ensure chest radiograph is ordered and reviewed post insertion (if required) Discuss possible complications following this procedure, for example, pneumothorax, bleeding, tube inserted incorrectly
5. Demonstrates the ability to assist with decannulation and can discuss potential complications	Can state the standards for decannulation Assemble the correct equipment for decannulation Identifies personnel required to assist/support during the procedure Demonstrates the procedure safely and correctly Discuss possible complications following this procedure, for example, ineffective cough, aspiration, exhaustion
6. Demonstrates the ability to perform tracheal suctioning	Identify the need for suction Assemble the correct equipment – including correct size catheters Demonstrate and understand the need for aseptic technique throughout Explain the procedure to the patient Discuss complications and interventions to reduce risk Demonstrate good suction technique Evaluate effectiveness of suctioning Demonstrate correct documentation and reporting as necessary
7. Demonstrates and discusses the nursing care for a patient with a tracheostomy tube	Discuss the importance of humidification Demonstrate the ability to care for tracheostomy tube, including cleaning of inner tube Discuss the care of the stoma, including appropriate selection of dressings and tapes Patient positioning and comfort Discuss issues with communication Discuss the role of speech therapy in assessing the swallow reflex

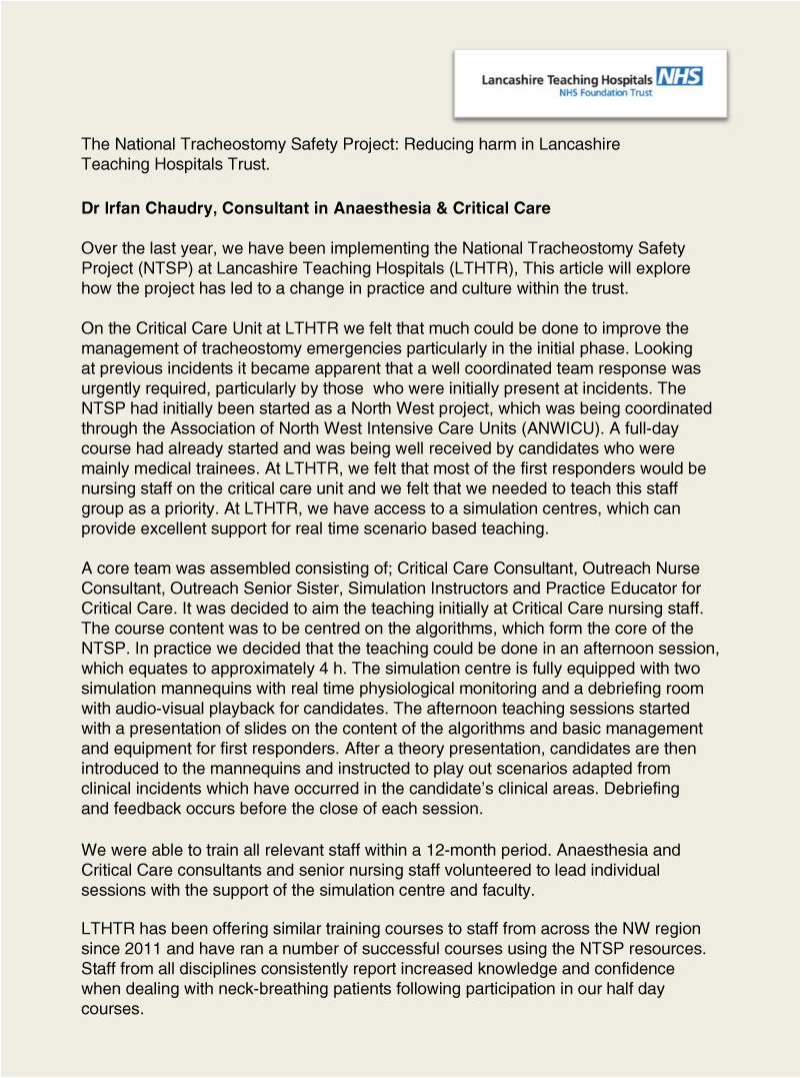
8. Demonstrates the ability to perform an accurate respiratory assessment with reference to specific tracheostomy checks	Describe the routine respiratory observations and their significance in patient assessment Discuss how these observations alter in respiratory failure Discuss normal blood gas values and how they alter in respiratory failure Assess the effectiveness of respiratory support Demonstrates and understands the measurement of cuff pressures Demonstrates and understands the use of end-tidal CO_2 monitoring
9. Discuss the 'red flag' indicators that represent tracheostomy problems	Discuss red flag indicators that represent tracheostomy problems, for example, inability to pass suction catheter, vocalising with cuff up, added sounds, increasing respiratory distress
10. Discuss and demonstrate the use of the emergency equipment needed for a tracheostomy emergency	Assemble the equipment required at the bed side and describe the use Discuss where the emergency equipment and fibreoptic scope are located Discuss their role in an emergency situation Demonstrates understanding of the use of all equipment
11. Demonstrate the emergency algorithm for tracheostomy patients	Able to discuss the algorithm Understands the importance of each step Demonstrates the need to get help immediately Demonstrate the algorithm in a scenario
12. Demonstrate the emergency algorithm for laryngectomy patients	Able to discuss the algorithm Understands the importance of each step Demonstrates the need to get help immediately Demonstrate the algorithm in a scenario
13. Demonstrates correct documentation and reporting as necessary	Refer to local policy or guidelines Use of observation charts Use of nursing documentation Use of bedhead signs Clear, legible, timely documentation

This list has been adapted from the Central Manchester NHS FT guidelines and is available as a PDF from www.tracheostomy.org.uk.

Implementation

The NTSP asked two colleagues who work in large NHS trusts in the North West of England to describe how they have implemented these resources in their trusts. Their accounts describe some of the barriers to implementation and how these were overcome (Figures 11.1 and 11.2).

Figure 11.1 Implementation at LTHTR.



Lancashire Teaching Hospitals NHS
NHS Foundation Trust

The National Tracheostomy Safety Project: Reducing harm in Lancashire Teaching Hospitals Trust.

Dr Irfan Chaudry, Consultant in Anaesthesia & Critical Care

Over the last year, we have been implementing the National Tracheostomy Safety Project (NTSP) at Lancashire Teaching Hospitals (LTHTR), This article will explore how the project has led to a change in practice and culture within the trust.

On the Critical Care Unit at LTHTR we felt that much could be done to improve the management of tracheostomy emergencies particularly in the initial phase. Looking at previous incidents it became apparent that a well coordinated team response was urgently required, particularly by those who were initially present at incidents. The NTSP had initially been started as a North West project, which was being coordinated through the Association of North West Intensive Care Units (ANWICU). A full-day course had already started and was being well received by candidates who were mainly medical trainees. At LTHTR, we felt that most of the first responders would be nursing staff on the critical care unit and we felt that we needed to teach this staff group as a priority. At LTHTR, we have access to a simulation centres, which can provide excellent support for real time scenario based teaching.

A core team was assembled consisting of; Critical Care Consultant, Outreach Nurse Consultant, Outreach Senior Sister, Simulation Instructors and Practice Educator for Critical Care. It was decided to aim the teaching initially at Critical Care nursing staff. The course content was to be centred on the algorithms, which form the core of the NTSP. In practice we decided that the teaching could be done in an afternoon session, which equates to approximately 4 h. The simulation centre is fully equipped with two simulation mannequins with real time physiological monitoring and a debriefing room with audio-visual playback for candidates. The afternoon teaching sessions started with a presentation of slides on the content of the algorithms and basic management and equipment for first responders. After a theory presentation, candidates are then introduced to the mannequins and instructed to play out scenarios adapted from clinical incidents which have occurred in the candidate's clinical areas. Debriefing and feedback occurs before the close of each session.

We were able to train all relevant staff within a 12-month period. Anaesthesia and Critical Care consultants and senior nursing staff volunteered to lead individual sessions with the support of the simulation centre and faculty.

LTHTR has been offering similar training courses to staff from across the NW region since 2011 and have ran a number of successful courses using the NTSP resources. Staff from all disciplines consistently report increased knowledge and confidence when dealing with neck-breathing patients following participation in our half day courses.

Figure 11.2 Implementation at SRFT. SRFT, Salford Royal NHS Foundation Trust.

Tracheostomy safety at Salford Royal Hospital FT

Dr Anna Perks, Consultant Anaesthetist

Salford Royal Hospital is a 850-bedded tertiary neurosciences centre, with 17 ICU beds, 26 HDU beds and a total of 10 cohort wards which accept patients with tracheostomies.

In 2008, the North West Regional tracheostomy group was established in our region. With the goal of introducing their emergency algorithms, I made enquiries as to what training and policies were already in place. There was a huge response and enthusiasm from colleagues in ENT and neurosciences, which lead to the formation of our 'Tracheostomy Steering Group' to address all aspects of tracheostomy care including equipment standardization and coherence of training throughout the trust.

Having a steering group with representation from neurosciences, ENT, speech and language, resuscitation training, rehab and critical care, we were in a strong position to overhaul tracheostomy care, whilst implementing the now National Tracheostomy Safety Project's work.

There were several issues to address to make progress. The emergency algorithms are free to access from the www.tracheostomy.org.uk website, but their implementation required training, access to resources and use of the bedhead signs.

Taking simplified versions of the case scenarios and two lectures on tracheostomy basics and an introduction to the algorithms from the NW regional course, we set up a 2-h teaching session for medical and nursing staff to attend. Early involvement of Alan Jervis on the resuscitation team meant ready access to tracheostomy manikins and use of their facilities in the Mayo building. The resus team have also taken our scenarios onto the wards for their daily teaching with the junior doctors on the crash team, to ensure that there are ongoing refresher sessions throughout the year on the wards. Our anaesthetic registrars have also been encouraged by the deanery to attend the advanced tracheostomy management course run by the NW regional group, to ensure that when expert help is requested that it is more likely to arrive!

There are various items of equipment, which are not standard to the resus trolley, but are required for the emergency algorithms. Safe tracheostomy care also requires that the patient has a spare inner cannula at the bedside for when it needs changing or cleaning. The tracheostomy care bundle was already in the process of implementation, ensuring various items are present and checked regularly. In order to simplify tracheostomy equipment, we decided on an additional box, which contains a Water's circuit paediatric face mask and other vital items, to sit on top of the current resus trolleys on each cohort ward. These boxes also contain copies of the algorithms.

The final hurdle was the use of the bed head sign. There was initial reluctance from the Information Governance lead here due to the risk of breaching patient confidentiality. The idea of publishing a patient's tracheostomy details was likened to having an HIV status sign above their heads! Using the argument that the sign merely colour coded a medical device, which could be seen by anyone looking at the patient softened the blow and approval was given provided that only unit number and not patient name was shown.

To cover all nursing and medical staff on cohort wards, plus the hospital at night team and matrons, we estimate there are over 600 staff to train. There will be a lag period before we can realistically make this training mandatory, but approximately 150 staff have already completed the training and we have provision for all to be trained within a 12-month period. We have strong support from post-graduate education and ward managers and together, we are working towards making the wards safer for this group of patients.

Anna Perks

Chapter 12

Courses

The NTSP has been running courses teaching basic, intermediate and advanced management of tracheostomy emergencies since 2008. Resources have been developed for the first responder and also for those who will attend as airway experts. 'Train the Trainer' days have allowed other Trusts, Regions and Community organisations to develop their own local training, supported by the NTSP resources.

NTSP courses now run in partnership with the ALSG (www.alsg.org). This is because of an overwhelming increase in demand for primary and secondary training around the UK. ALSG is a UK-based charity providing training in over 37 countries around the world for courses such as Advanced Paediatric Life Support (APLS), Advanced Trauma Life Support (ATLS), MedicALS and Safe Transfer and Retrieval (STaR). The ALSG courses provide standardised, international, professional courses, resources and instructors.

One of the advantages of multi-disciplinary courses, especially if held in your own organisation, is that it brings together key personnel who will be involved in managing routine and emergency care. Staff from different backgrounds provide different approaches to care and are a resource for each other. Future working practices are usually a lot easier when you know your colleagues, especially in a large organisation (Figures 12.1–12.5).

Figure 12.1

Advanced Life Support Group

A charity dedicated to saving life by providing training

Figure 12.2

Figure 12.3

Figure 12.4

Figure 12.5

Involving local industry representatives is another advantage and the NTSP has strongly encouraged links with industry, where possible. Being able to handle and discuss the variety of devices and ancillary equipment available is extremely useful: the worst time to encounter a new or unfamiliar device is in an emergency.

Chapter 13

Human factors

Introduction

Error is inevitable, but harm is not

Sarah Corcoran, Associate Director of Clinical Effectiveness, Central Manchester Foundation Trust, 2009

This manual provides information and resources for the safe management of tracheostomy and laryngectomy care, but also is focused on the assessment and management of the acutely ill patient. Responders are frequently required to utilise their knowledge and skills to care for a collapsed, or deteriorating, patient who is only one of several concurrent responsibilities.

Although the ideal of each patient being managed by a dedicated, focused, mentally and physically fit, smoothly functioning team, without interruptions or distractions, cannot be achieved, ways of working can be adopted that optimise the quality of patient care and minimise the risk of error even under the most difficult of circumstances.

The performance of individuals and teams working in complex, high-pressure environments is influenced by a wide range of intrinsic (personal) and extrinsic (environmental) factors. Some 20 years ago, the aviation industry began to take account of these factors, how they impact on human performance and their significance for flight safety. Today, all airline staff are required to undergo a rigorous *human factors* training programme that equips them with the skills to recognise risky situations and behaviours and the tools to lead their team towards the safest methods of operation. More recently, this has started to be adopted within healthcare as a means of improving safety and quality. The Department of Health recommends human factors training as a way of improving safety (CMO Report 2008, Safer Medical Practice).

This chapter provides a brief overview of the human factors that can affect the performance of individuals and teams in the healthcare environment. The reader is encouraged to consider these factors in their everyday practice. Those attending the courses associated with this manual may receive direct feedback on their performance in this area. By the end of this chapter, the reader should understand the concept of human error in individuals and in teams and appreciate how situation awareness and good communication can help minimise the effects of error.

Human error

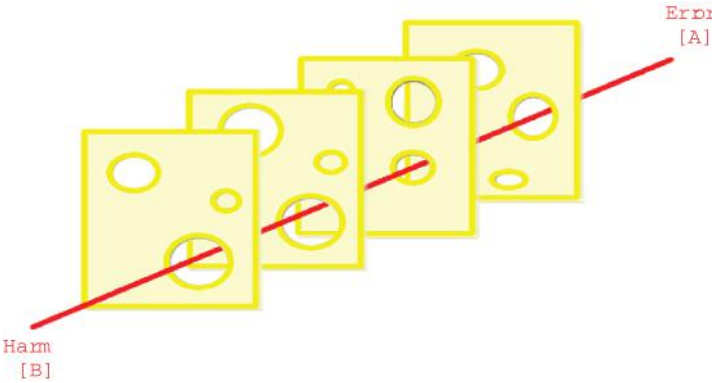
Humans make mistakes. No amount of checks and procedures will obviate this fact. Consequently, it is vital to work in a way that, as well as decreasing the occurrence of mistakes, ensures that when they do occur the resulting threat to patient safety is minimised.

Error chains

Patient safety is only rarely compromised by a single mistake. Almost always a mistake or error A leads to harm B because of a series of factors that set up the conditions such that error A resulted in event B and without which event B would not have occurred. This is known as the error chain. This is the basis of the 'Swiss cheese' model (Figure 13.1).

Figure 13.1 'Swiss cheese' model.

Reproduced with permission from ALSG and Dr Peter-Marc Fortune.



Each of the slices of cheese represents barriers that should prevent A leading to B. However, such checks and balances can fail. This is represented by the holes in the slices. For A to lead to B, the holes of all the intervening slices need to line up. Simplistically viewed, the more checks that are put in place, the less likely an error is to occur. However, increasing complexity can be counterproductive, as humans will avoid or modify multiple steps to make life easier.

Consider the following critical incident:

The wrong dose of a drug has been administered to a patient by a clinician. Why?

We know that the clinician should have checked the details of the prescription and the calculations and ensured that this all matched up with the formulation and strength of the medications administered. People do not usually deliberately give the wrong dose and therefore it is not unreasonable to conclude that the clinician thought he had checked and matched everything as described.

So why did the error occur?

Further investigation revealed that the two drugs had been replaced in one another's normal positions in the ward trolley. The packaging of the two drugs was very similar (Figure 13.2).

Figure 13.2 Similar package designs of two different medications.

Reproduced with permission from ALSG and Dr Peter-Marc Fortune.

The clinician picked the medication from its usual place, the box having been recognised, and therefore didn't actively check the name and concentration of the drug. Habit can blind us to what we are doing. The problems of uniform packaging have been recognised and highlighted through a national adverse incident reporting system and recommendations made that packages for different strength medications should now look completely different. This change in practice is an example of how human factors theory is used to reduce the risk of error.

In the working environment, we may be present at the right time to observe the breaching of a barrier that would normally prevent errors occurring. It is critical that we are vigilant for these breaches and draw the attention of our colleagues to them in order to prevent the completion of an error chain. Events or conditions that are suspected of representing potential breaches in barriers preventing harm are referred to as red flags. The more red flags that arise, the greater the risk of an adverse incident occurring and therefore the greater the need to alert those involved to stop and review the situation.

Communication

Problems with communication underpin a significant proportion of critical events.

When the speaker and listener do not share the same language, the obvious solution is to use an interpreter. However, there are limitations to discussions carried out through a third party. What about the issues that arise if one of the parties is communicating using their second language? Even when all parties are utilising their native tongue, non-verbal signals carry as much, if not more, information and meaning, than the words themselves. Non-verbal communication, outside the actual words we use, has been shown to contribute up to 93% of what we understand (Koneya and Barbour, 1976). Barbour's study identified that 38% of communication relates to how words are said (volume, pitch, rhythm, etc.) and 55% body language (facial expressions, posture, etc.). When those trying to communicate come from different cultural backgrounds, both verbal and non-verbal elements can be completely misinterpreted by both parties.

Studies have shown that we understand around 60% of verbal and 50% of written communication, the remainder being miscommunicated, misinterpreted or simply misunderstood. It is not hard to see why in a busy clinical environment, when multiple tasks are being undertaken and contact is frequently electronic or telephonic, rather than face to face, miscommunication occurs so frequently. The process of communication can be described as three separate phases:

1. **The sender**: This is the process within which the originator articulates the message in the mind, in what is perceived to be a meaningful and contextual manner.
2. **The channel**: This is the medium of communication chosen: verbal, non-verbal or written.
3. **The receiver**: This is the process within which the intended recipient makes sense of the information. This is easily distorted by the use of euphemisms or localised terminology.

The resulting outcome in a noisy highly pressured clinical arena is unsurprisingly one of poor information exchange. A technique to improve communication is the feedback loop. This is a process by which the receiver repeats the message back to the sender to acknowledge receipt and confirm that it has been correctly deciphered. It is quick and simple to use, easy to teach and has been shown to produce immediate benefit in busy clinical areas where requests and instructions are being passed on at breakneck speed.

To aid with communication when handing over care from one team/person to another, the SBAR tool is recommended (Box 13.1).

Box 13.1

S Situation: a concise statement of the problem

B Background: pertinent information related to the situation

A Assessment: analysis and considerations of options—what you found/think

R Recommendation: action requested/recommended—what you want to do

This formalises and structures the information transfer, helping to avoid assumptions of knowledge and highlighting the plan for ongoing care (recommendation). In summary, this discussion only begins to touch on the complexity of human communication. Beyond this there are many layers of subtlety in our interactions. To try and mitigate the risk of miscommunication, it is vital that both talkers and listeners actively engage in the process.

Body language and Hierarchy

All individuals should always be aware of their non-verbal signals. Messages that say ‘I’m bored', ‘I’m tired' or ‘I don’t value you' can inhibit another person from passing on a key piece of information. The presence of a steep hierarchy can be particularly dangerous as it promotes an attitude of indifference to the input of those further down the pyramid. A culture where junior staff do not feel empowered to speak directly to senior staff, or senior staff are dismissive about concerns raised by junior staff, is inherently unsafe. If the clinical assistant walks into the theatre and sees an expanding pool of blood under the operating table, the assistant should feel able to voice concerns. Whether or not it proves to be clinically important, the input should be positively acknowledged, as next time the assistant might be the first to identify a critical issue.

Speaking up

Box 13.2

Stage—Level of concern

P*—Probe I think you need to know what is happening*

A*—Alert I think something bad might happen*

C*—Challenge I know something bad will happen*

E*—Emergency I will not let it happen*

A useful communication tool, utilised by the airline industry, is shown in Box 13.2. This structure can be used by any person who is concerned that he or she has information that might be important to others on the team. The levels *Probe, Alert, Challenge and Emergency* are utilised sequentially to express increasing concern. If a disaster is imminent, it is entirely appropriate to use the *Challenge* or even *Emergency* stages without recourse to the initial stages. Both the speaker and the listener should recognise the level of the communication and react appropriately. In the aviation industry, reaching the level of *Challenge* on the flight deck prompts a serious review, whether or not an incident occurs.

These stages are described with examples.

Probe: When the observer points out something that might be a problem. 'Doctor I think this woman is cyanosed, should we give some oxygen?'

Alert: It is used if there is no response to the first prompt and the situation continues. The observer strengthens the statement and suggests a course of action. 'Doctor, I am concerned the woman is deeply cyanosed; we must intervene to support her oxygenation before she deteriorates further.'

Challenge: The situation requires urgent attention. One of the key protagonists needs to be directly engaged. If possible the speaker should be in the eye line of vision of the person they with whom the communication is carried on. 'Dr Adams - this patient is cyanosed, by not intervening you are placing her at significant risk of cardiorespiratory collapse and brain damage. You must stop what you are doing and intervene to support her ventilation now.'

Emergency: It is used where all else has failed and/or the observer perceives a critical event is about to occur. If possible, physical action should accompany clear verbalisation. 'Dr Adams, your inaction is placing this lady in danger; please move out of the way I am going to take over and bag-valve-mask ventilate this lady now.'

Organisations that use this, or similar, systems sometimes make use of a code word or phrase to flag the level of concern. These may then be used to gain both the team's and a key individual's attention. For example, ‘Code Orange, Code Orange, please stop and listen.’

Situation awareness

People do not come to work to harm patients. When errors occur, they do so because the person making the mistake does not realise that the action will cause harm to the patient. If we have insufficient or incomplete information, we can draw the wrong conclusions about what is going on. For example, we can make a misdiagnosis. If we then intervene on the basis of that flawed diagnosis, it is not difficult to see that harm may ensue.

Good situation awareness is achieved when we have sufficient and correct information, have interpreted it correctly and correctly project the outcome of an intervention into the future, based on our current knowledge.

Consider the picture in Figure 13.3. What do you see? Around half of the readers will see a young woman looking back/right and the other half will see an old woman looking forward/right (a few may see both). This is a simple example of how two people can look at the same thing and yet make different interpretations.

Figure 13.3 Illustration of situation awareness.

Reproduced with permission from ALSG and Dr Peter-Marc Fortune.

The way we perceive a particular situation is affected by the information conveyed via our own sensorium, our past experience (an experienced clinician might recognise a compromised patient more rapidly than a junior), our level of alertness, our current workload and the influence of intercurrent distractions.

In psychological terms, our perception of the current situation is fitted into a model in our minds, based on our knowledge and previous experiences. We use this model to plan our next actions and anticipate the outcome of those actions. A simple example of this is a woman presenting with epigastric pain, with a previous history of severe pre-eclampsia in the last pregnancy. The clinician assessing the woman might conclude that she is suffering from gastroenteritis because of inexperience, or insufficient information (the history of previous pre-eclampsia) secondary to tiredness or distractions.

The loss of situation awareness is often triggered by the undertaking of a specific psychomotor task; an example would be the team leader who had

maintained objectivity and an overall assessment of events, until he undertakes a specific task that greatly reduces his ability to receive and process information. Clinical staff have reported a complete loss of situation awareness, while undertaking complex tasks, in that they did not hear alarms or other team members alerting them to specific dangers. If it is the team leader undertaking the task and the team are also involved in busy practice, then it is not unusual for the entire team to miss critical elements of information that, if recognised, would have directly contributed to the correct diagnosis and care of the patient.

A common trap that people fall into is only seeing or registering the information that fits in with their current mental model. This is known as a *confirmation bias*. When this occurs, people favour information that confirms their preconceptions or hypotheses regardless of whether the information is true.

For example, a clinician receives a phone call requesting them for a review of an acutely deteriorating patient who is known to be asthmatic. Before seeing the patient, the clinician builds up a series of preconceived expectations of what will be found. The clinician may even formulate a management plan based on these expectations. Once this mindset is established, it can be difficult to change. The clinician proceeds to examine only the systems affected by the presumed diagnosis and seeks to confirm the expectation by focusing on auscultation of the chest at the expense of a thorough airway assessment. On hearing the bilateral wheeze, the clinician's preconceived ideas are confirmed and the remainder of the assessment is completed without due attention and more as a rehearsed exercise than an open-minded exploration. The clinician fails to notice that the patient also has a soft stridor and is hypotensive.

Alternatively, the clinician knows there are several other patients to get to and for this reason does not undertake a thorough assessment. The junior staff in attendance point out hypotension and signs of upper airway obstruction, but the clinician fails to recognise the significance of these signs. This occurs because the clinician is psychologically holding onto the preconceived diagnosis. In this situation the clinician may dismiss these conflicting findings, or may even manipulate the findings to fit the preconceived mental model.

In both cases, the eventual diagnosis of anaphylaxis becomes a late consideration, or a situation that requires an objective newcomer to the team to point out the obvious.

Other examples of this loss of situation awareness relating to technical skills include the obstetrician who persists at operative vaginal delivery with all their attention focused on successful completion of the procedure, rather than on critically assessing progress during traction; or the anaesthetist who doesn't recognise oesophageal intubation because, ‘It felt right’, or they are sure they saw the chest move.

It is vital that each individual understands the concept of situation awareness and continually questions their own thought processes and those of others around them. Remembering the possibility of the worst-case scenario helps to review things critically, to recognise warning signs early and avoid catastrophe. The whole team should also share their impressions of the current situation. There is good evidence that the situation awareness of a well functioning team is actually greater than the sum of its individual parts. This may be in part due to the elimination of bad data. Information or comments by colleagues that are out with one's current mental picture should be treated as a trigger to consider whether anyone's situation awareness is lacking. A discussion of the disparity should uncover the true picture. Problems occur when individuals either ignore or rationalise the errant data to fit into their current picture of the world, rather than treat it as a challenge.

Fatigue

When we are tired, we find it more difficult to absorb and process information, we react more slowly and mood can be affected. We may become impatient, uninterested and irritable. The negative impact on the ability to function individually and as part of a team is obvious.

Clinicians work in a highly pressured environment with the expectation that even when we know we are not functioning at 100% capacity, we will cope with a crisis. In a safe culture, staff need to feel able to say, ‘I’m not fit to do this', and know they will have the support of their colleagues. While it seems obvious that we need to ensure that fatigued people are not

working at the sharp end of healthcare delivery, this is not currently part of the mindset. This is a culture change we all need to embrace.

Even when prolonged or arduous shifts are avoided, circadian rhythms can produce adverse psychological and physiological changes. This is relevant as clinicians routinely work shifts, including nights and have quick turnaround between patterns of rest/work activity. It is perhaps unsurprising to note that all of the recent major disasters attributed to human error (Exxon Valdez oil spill, Three Mile Island, Bophal chemical plant explosion, Chernobyl) occurred on the night shift, when alertness is at its lowest point.

It is suggested that the following are caused by circadian rhythm disturbance:

- lack of concentration
- periods of inattention
- reduced vigilance
- reduction in alertness level
- slow actions
- alteration in short term memory
- loss of critical analysis and advocacy
- interpretation errors

Recognition of the impact of fatigue on our ability to perform carries with it important personal responsibilities. If circumstances arise which result in us being unfit for work in any way, we have the responsibility for flagging it up to colleagues and managers. They, in turn, should ensure that anyone reporting such concerns is supported and, where necessary, allowed to step down from front line duties, until fit. If this feels over-idealistic, consider the following—would you be comfortable boarding an aircraft when you knew the pilot had been up all night with his child who is critically unwell in hospital?

The discussions above are primarily focused on tiredness or fatigue due to lack of sleep. Physical or mental illness, use of medications, alcohol and personal stress can all manifest in a similar manner and require appropriate, sensitive management.

Decision making

In order to understand what factors can compromise the process of decision making, it is important to understand the factors that affect the reliability of any decision made. To reach a good decision, all aspects of a problem should be considered, all possible responses assessed and the consequences of those responses identified. The advantages and disadvantages of each course of action must be weighed up in order to draw a conclusion and make the decision. This must then be communicated to the team.

Good situation awareness is a prerequisite of this process. To achieve this, the decision maker must have all the key information. This is gathered through acquisition of data first hand (e.g. examining the patient yourself), and communication with their team. Decision makers should be on the alert to ambiguities or conflicting information. Any inconsistent fact should be treated as a potential marker for faulty situation awareness and not dismissed as unimportant anomalies in the absence of evidence to support such a decision.

No decision-making process should be concluded until the team are satisfied they have all the information and have considered all the options. Where time is a pressure, a certain amount of pragmatism must be employed. There is plenty of evidence to confirm that experience can mitigate some of the negative effects of abbreviating the decision-making process. Those making decisions under such circumstances need to remain consciously aware of the short cuts they have taken. They should be ready to receive feedback from their team, particularly if any member of the team has significant concerns about the proposed course of action. Practical limitations accepted, there are few situations where a delay of 1–2 min to share the rationale for the decision is not possible.

As discussed above, it is vital that team members feel able to raise their concerns and that the decision maker values and considers them appropriately. One only has to examine some of the high-profile medical incidents, such as the Elaine Bromley case (see Box 13.3), to see that junior clinicians were trying to voice their (correct) concerns from a time when, if they had been heard, it may have altered the outcome.

Box 13.3

Elaine Bromley died during a minor operation in 2005, after anaesthetists were unable to place an endotracheal tube. The doctors struggled for 20 minutes to insert the ET tube. They did not follow the standard, 'Can't intubate, can't ventilate,' protocol despite the appropriate kit being made available by theatre staff. During this episode Elaine Bromley suffered irreversible brain damage and subsequently died.

When decision-makers inappropriately or repeatedly disregard the opinions of others, this should be flagged up before an incident occurs.

Leadership: people, behaviours

The inevitable mix of personalities in a team will have implications for the smooth functioning of that team. In the pressured environment in which we work, latent personality traits, or even new ones, can be brought out. In extreme cases, this can manifest as aggressive or submissive affect. Depending on the individual and the team dynamics, this can be highly detrimental to the process of communication, situation awareness and decision-making.

Wherever possible, the adoption of a facilitative role can serve to draw the best from all members of the team. Every opportunity should be taken to debrief teams after an episode of working together. This can be enhanced where there is opportunity for the team to practise and reflect on their interactions in a simulated environment (Figure 13.4).

Figure 13.4 Critical incident rehearsals and simulation experience can improve the performance of individuals and teams when responding to emergencies.

Summary

We all work in a complex, pressured clinical environment. We are all responsible for patient safety and should be alert to red flags and voice concerns promptly. To do this, we need to recognise and respect both our own limitations and those of the people we work with. This safety surveillance is facilitated by an understanding of the human factors at play around us.

Acknowledgement

The NTSP are grateful to the Advanced Life Support Group and Dr Peter-Marc Fortune for permission to include this adapted chapter in this manual.

Further reading

www.institute.nhs.uk/safer_care/safer_care/Situation_Background_Assessment_Recommendation.html

Flin R., O'Connor P., Crichton M. (2008). *Safety at the Sharp End*. Hampshire, England, Ashgate Publishing Ltd.

Reason J. (2008). *The Human Contribution: Unsafe Acts, Accidents and Heroic Recoveries*. Surrey, England, Ashgate Publishing Ltd.

http://www.crm-devel.org/resources/paper/PACE.PDF (accessed 20/7/13).

http://www.youtube.com/watch?v=JzlvgtPIof4 'Just a routine operation'—Clinical Human Factors Group, founded by Martin Bromiley after the death of Elaine Bromiley, described in Box 13.3 (accessed 22/7/13).

Bibliography

The following references were reviewed and used when constructing this document. They include both adult references and specific paediatric references used by the GOSH team. References are listed alphabetically.

Ackerman, M.H., Gugerty, B.P. (1990). The effects of normal saline bolus instillation on artificial airways. *The Journal of the Society of Otolaryngology Nursing*, Spring: 14–7.

Ackerman, M.H., Mick, D.J. (1998). Instillation of normal saline before suctioning in patients with pulmonary infections: a prospective randomized controlled trial. *American Journal of Critical Care*, **7(**4**)**: 261–6.

Agarwal A, Singh D. (2010). Is fibreoptic percutaneous tracheostomy in ICU a breakthrough? *Journal of Anaesthesiology Clinical Pharmacology*, **26**: 514–6.

Ahn, Y., Hwang, T. (2003). The effects of shallow versus deep endotracheal suctioning on the cytological components of respiratory aspirates in high-risk infants. *Respiration*, **70(2)**: 172–8.

Akgul, S., Akycolcu, N. (2002). Effects of normal saline on endotracheal suctioning. *Journal of Clinical Nursing*, **11**: 826–30.

Albarzangi, L., Murphy, A., Browning, S.T. (2003). A novel method of managing a critical airway. *Laryngoscope*, **113(**9**)**: 1564–5.

American Society of Anesthesiologists. (1993). Practice guidelines for management of the difficult airway. A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*, **78**: 597–602.

American Society of Anesthesiologists. (2003). Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*, **98**: 1269–77.

American Thoracic Society. (2000). Care of the child with a chronic tracheostomy. *American Journal of Respiratory Critical Care Medicine*, **161**: 297–308.

Arora, A., Hettige, R., Ifeacho, S., Narula, A. (2008). Driving standards in tracheostomy care: a preliminary communication of the St Mary's ENT-led multidisciplinary team approach. *Clinical Otolaryngology*, **33(6)**: 596–9.

Arroyo-Novoa, C.M., Figueroa-Ramos, M.I., Puntillo, K.A., et al. (2008). Pain related to tracheal suctioning in awake acutely and critically ill adults: a descriptive study. *Intensive and Critical Care Nursing*, **24(1)**: 20–7.

Ashurst, S. (1992). Suction therapy in the critically ill patient. *British Journal of Nursing*, **1**: 485–9.

Association of Anaesthetists of Great Britain and Northern Ireland. AAGBI. (2011). The use of capnography outside the operating theatre. www.aagbi.org/sites/default/files/Safety Statement (accessed 3/8/2011).

Australian Resuscitation Council. (2006). Breathing: Australian Resuscitation Council guideline. *Emergency Medicine Australasia*, **18(4)**: 328–9.

Avena, M.J., de Carvalho, W.B., Beppu, O.S. (2003). Evaluation of oxygenation, ventilation and respiratory mechanics before and after endotracheal suction in mechanically ventilated children. *Revista da Associação Médica Brasileira*, **49(2)**: 156–61.

Awad, Z., Pothier, D.D. (2007). Management of surgical airway emergencies by junior ENT staff: a telephone survey. *The Journal of Laryngology & Otology*, **121(1)**: 57–60.

Bailey, C., Kattwinkel, J., Teja, K., Buckley, T. (1988). Shallow versus deep endotracheal suctioning in young rabbits: pathologic effects on the tracheobronchial wall. *Paediatric*, **82(5)**: 746–51.

Bell, S.D. (1996). Use of Passy-Muir tracheostomy speaking valve in mechanically ventilated neurological patients. *Critical Care Nurse*, **16**: 63–8.

Benumof, J.L. (1991). Management of the difficult adult airway. With special emphasis on awake tracheal intubation. *Anesthesiology*, **75**: 1087–110.

Bernard, A.C., Kenady, D.E. (1999). Conventional surgical tracheostomy as the preferred method of airway management. *Journal of Oral and Maxillofacial Surgery*, **57(**3**)**: 310–5.

Bhalla, R.K., Corrigan, A., Roland, N.J. (2004). Comparison of two face masks used to deliver early ventilation to laryngectomized patients. *Ear Nose & Throat Journal*, **83**: 414–6.

Bhuvanagiri, A., Thirugnanam, M., Rehman, K., Grew, N.R. (2007). Repositioning a displaced tracheostomy tube. *British Journal of Anaesthesia*, **98(**2**)**: 276–9.

Bier, J., Hazarian, L., McCabe, D., Perez, Y. (2004). Giving your patient a voice with a tracheostomy speaking valve. *Nursing*, Autumn(Supplement): 16–8.

Billau, C. (2004). Suctioning (Chapter 9). In Russell, C., Matta, B. (Eds). *Tracheostomy: A Multi-Professional Handbook*. Cambridge, Cambridge University Press.

Bjork, V.O. (1960). Partial resection of the only remaining lung with the aid of respirator treatment. *Journal of Thoracic and Cardiovascular Surgery*, **39**: 179–88.

Bjorling, G., Belin, A.L., Hellstrom, C., et al. (2007). Tracheostomy inner cannula care: a randomized crossover study of two decontamination procedures. *American Journal of Infection Control*, **35(**9**)**: 600–5.

Blackwood, B. (1999). Normal saline instillation with endotracheal suctioning: primum non nocere (first do no harm). *Journal of Advanced Nursing*, **29(**4**)**: 928–34.

Bloggs, R.L. (1993). *Airway management in AACN Procedural Manual for Critical Care* (3rd edition). Philadelphia, WB Saunders Co.

Bond, P., Grant, F., Coltart, L., Elder, F. (2003). Best practice in the care of patients with a tracheostomy. *Nursing Times*, **99**: 24–5.

Borges, B.C., Boet, S., Siu, L.W., et al. (2010). Incomplete adherence to the ASA difficult airway algorithm is unchanged after a high-fidelity simulation session. *Canadian Journal of Anaesthesia*, **57**: 644–9.

Bradley, P.J. (2009). Bleeding around a tracheostomy wound: what to consider and what to do? *The Journal of Laryngology & Otology*, **123(**9**)**: 952–6.

Branson, R. (1999). Humidification for patients with artificial airways. *Respiratory Care*, **44(**6**)**: 630–42.

Brodsky, L., Reidy, M., Stanievish, J.F. (1987). The effects of suctioning techniques on the distal mucosa in intubated low birthweight infants. *Journal of Otoshinolaryngology*, **14(1)**: 1–14.

Brook, I. (2011). A physician's personal experience as a neck breather needing emergency care. *American Journal of Emergency Medicine*, **29(**2**)**: 233–4.

Brooke, J. (2000). Humidification in paediatric anaesthesia. *Paediatric Anaesthesia Journal*, **10(2)**: 117–9.

Bryant, K., Davis, C., Lagrone, C. (1997). Streamlining discharge planning for the child with a new tracheotomy. *Journal of Pediatric Nursing*, **12(**3**)**: 191–2.

Buglass, E. (1999). Tracheostomy care: tracheal suctioning and humidification. *British Journal of Nursing*, **8(**8**)**: 500–4.

Burke, A. (1981). The advantages of stay sutures with tracheostomy. *Annals of the Royal College of Surgeons of England*, **63**: 426–8.

Buzz-Kelly, L., Gordin, P. (1993). Teaching CPR to parents of children with tracheostomies. *MCN: The American Journal of Maternity/Child Nursing*, **18(**3**)**: 158–63.

Byard, R.W., Gilbert, J.D. (2011). Potentially lethal complications of tracheostomy: autopsy considerations published as 'ePub ahead of print'. *American Journal of Forensic Medicine and Pathology*, Aug 3; doi: 10.1097/PAF.0b013e31822abf4e.

Byhahn, C., Lischke, V., Meininger, D., et al. (2005). Peri-operative complications during percutaneous tracheostomy in obese patients. *Anaesthesia*, **60**: 12–5.

Campbell, R., Davis, K., Johannigman, R., Branson, R. (2000). The effects of passive humidifier dead space on respiratory variables in

paralysed and spontaneously breathing patients. *Respiratory Care*, **45(**3**)**: 306–12.

Carpen, H. (2005). Sydney West Area Health Service Tracheostomy Care guidelines. www.swahs.health.nsw.gov.au (accessed 20/6/2009).

Carroll, P. (1998). Closing in on safer suctioning. *RN Journal*, **61(5)**: 22–7.

Chadda, K., Louis, B., Benaissa, L., et al. (2002). Physiological effects of decannulation in tracheostomized patients. *Intensive Care Medicine*, **28(**12**)**: 1761–7.

Chameides, L., Hazinski, M.F. (Eds). (1997). *Paediatric Advanced Life Support*. Dallas, American Heart Association.

Cheng, K.S., Ng, J.M. (2002). Airway loss during tracheostomy. *Canadian Journal of Anaesthesia*, **49**: 110–1.

Coleman, N.A., Power, B.M., van Heerden, P.V. (2000). The use of end-tidal carbon dioxide monitoring to confirm intratracheal cannula placement prior to percutaneous dilatational tracheostomy. *Anaesthesia & Intensive Care*, **28**: 191–2.

Collard, H., Saint, S., Matthay, M. (2003). Prevention of ventilator associated pneumonia: an evidence based systematic review. *Annals of Internal Medicine*, **138(6)**: 494–501.

Conway, J.H., Holgate, S.T. (1991). Humidification for patients with chronic chest disease. *Problems of Respiratory Care*, **4**: 463–67.

Conway, J.H., Fleming, J.S., Perring, S., Holgate, S.T. (1992). Humidification as an adjunct to chest physiotherapy in aiding tracho-bronchial clearance in patients with bronchiectasis. *Respiratory Medicine*, **86**: 109–14.

Cook, T., Woodall, N. (2011). Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Section 3: Appendices, 2011. www.rcoa.ac.uk/docs/NAP4_Section3.pdf (accessed 6/10/2011).

Cook, T.M., Woodall, N., Frerk, C., and on behalf of the Fourth National Audit Project. (2011). Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia. *British Journal of Anaesthesia*, **106(**5**)**: 617–31.

Cook, T.M., Woodall, N., Harper, J., Benger, J. and on behalf of the Fourth National Audit Project. (2011). Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. *British Journal of Anaesthesia*, **106(**5**)**: 632–42.

Cooke, J., Thorpe, V., Anderson, J. (2001). *Living with Tracheostomy. GOSH Family Resource, Parents Information Booklet*. London, Great Ormond Street Hospital.

Copnell, B., Fergusson, D. (1995). Endotracheal suctioning: time-worn ritual or timely intervention? *American Journal of Critical Care*, **4(**2**)**: 100–5.

Cordero, L., Sananes, M., Ayers, L.W. (2001). A comparison of two airway suctioning frequencies in mechanically ventilated, very-low-birthweight infants. *Respiratory Care*, **46(**8**)**: 783–8.

Cormack, R.S., Lehane, J. (1984). Difficult tracheal intubation in obstetrics. *Anaesthesia* **39**: 1105–11.

Cormack, R.S., Rocke, D.A., Latto, I.P., Cooper, G.M. (2006). Failed intubation in obstetric anaesthesia. *Anaesthesia*, **61(**2**)**: 192–3.

Cosgrove, J.E., Sweenie, A., Raftery, G., et al. (2006). Locally developed guidelines reduce immediate complications from percutaneous dilatational tracheostomy using the Ciaglia Blue Rhino technique: a report on 200 procedures. *Anaesthesia & Intensive Care*, **34**: 782–6.

Cowan, T., Op't Holt, T.B., Gegenheimer, C., et al. (2001). Effect of inner cannula removal on the work of breathing imposed by tracheostomy tubes: a bench study. *Respiratory Care*, **46**: 460–5.

Crawley, B.E. (1982). The complications of tracheostomy. *Middle East Journal of Anaesthesiology*, **6**: 605–18.

Crosby, E. (2010). The role of simulator-based assessments in physician competency evaluations. *Canadian Journal of Anaesthesia*, **57**: 627–35.

Crosby, E.T., Cooper, R.M., Douglas, M.J., et al. (1998). The unanticipated difficult airway with recommendations for management. *Canadian Journal of Anaesthesia*, **45**: 757–76.

Czarnik, R.E., Stone, K.S., Everhart, C.C. Jr. Preusser, B.A. (1991). Differential effects of continuous versus intermittent suction on tracheal tissue. *Heart Lung*, **20(**2**)**: 144–51.

Dajlby, R.W., Hogg, J.C. (1980). Effects of breathing dry air on structure and function of airways. *Journal of Applied Physiology*, **61**: 312–7.

Darrat, I., Yaremchuk, K. (2008). Early mortality rate of morbidly obese patients after tracheotomy. *Laryngoscope*, **118**: 2125–8.

Dawson, D. (2008). St George's Hospital Healthcare Trust/Tracheostomy Emergency algorithm, 2008. www.stgeorges.nhs.uk/trachindex.asp (accessed 1/6/2009).

Day, T., Farnell, S., Haynes, S., et al. (2002). Tracheal suctioning: an exploration of nurses' knowledge and competence in acute and high dependency ward areas. *Journal of Advanced Nursing*, **39(**1**)**: 35–45.

Day, T., Iles, N., Griffiths, P. (2009). Effect of performance feedback on tracheal suctioning knowledge and skills: randomized controlled trial. *Journal of Advanced Nursing*, **65(7)**: 1423–31.

Dean, B. (1997). Evidence based suction management in accident and emergency—a vital component of airway care. *Accident and Emergency Nursing*, **5**: 92–98.

Dellinger, K. (2001). Suction injuries: education is the key to prevention. *Journal of Pediatric Nursing*, **16(**3**)**: 147–8.

Department of Health Social Services and Public Safety [Northern Ireland] (McBride, M.). (2009). Reducing the risks associated with the management of a patient with a tracheostomy. www.dhsspsni.gov.uk/s___q_learning_communication_07_09_-_management_of_a_patient_with_a_tracheoston (accessed 14/6/2009).

Deutsch, E.S. (1998). Early tracheostomy tube change in children. *Archives of Otolaryngology—Head & Neck Surgery*, **124(**11**)**: 1237–8.

Diaz-Reganon, G., Minambres, E., Ruiz, A., et al. (2008). Safety and complications of percutaneous tracheostomy in a cohort of 800 mixed ICU patients. *Anaesthesia*, **63(**11**)**: 1198–203.

Difficult Airway Society. (2009). Airway alert form. www.das.uk.com/guidelines/downloads.html (accessed 3/8/2011).

Dixon, L. (1998). Tracheostomy: easing the transition from hospital to home. *Perspectives*, **1(**3**)**: 1–6.

Docherty, B., Bench, S. (2002). Tracheostomy management for patients in general ward settings. *Professional Nurse*, **18**: 100–4.

Donald, K.J., Robertson, V.J., Tsebelis, K. (2000). Setting safe and effective suction pressure: the effect of using a manometer in the suction circuit. *Intensive Care Medicine*, **26(**1**)**: 15–9.

Douglas, W.E., Flabouris, A. (1999). Surgical emphysema following percutaneous tracheostomy. *Anaesthesia & Intensive Care*, **27**: 69–72.

Dubey, S.P., Garap, J.P. (1999). Paediatric tracheostomy: an analysis of 40 cases. *The Journal of Laryngology & Otology*, **113(**7**)**: 645–51.

Eckerborn, B., Lindholm, C. (1990). Performance evaluation of six heat and moisture exchangers according to the draft ISO standards (ISO/DIS 9360). *Actual Anaesthesiology Science*, **34**: 404–9.

Edwards, E.S., Byrnes, C.A. (1999). Humidification difficulties in two tracheostomised children. *Anaesthesia & Intensive Care*, **27**: 656–8.

Eisenhauer, B. (1996). Actionstat. Dislodged tracheostomy tube. *Nursing*, **26(**6**)**: 25.

El Solh, A.A., Jaafar, W. (2007). A comparative study of the complications of surgical tracheostomy in morbidly obese critically ill patients. *Critical Care*, **11(**1**)**: R3.

El-Sayed, I.H., Ryan, S., Schell, H., et al. (2010). Identifying and improving knowledge deficits of emergency airway management of tracheotomy and laryngectomy patients: a pilot patient safety initiative. *International Journal of Otolaryngology*, **2010**: 638742.

Epstein, S.K., Nevins, M.L., Chung, J. (2000). Effect of unplanned extubation on outcome of mechanical ventilation. *American Journal of Respiratory Critical Care Medicine*, **161**: 1912–6.

European Section and Board of Anaesthesiology. EBA recommendation for the use of capnography. www.eba-uems.eu/resources/PDFS/EBA-UEMS-recommendation-for-use-of-Capnography.pdf (accessed 6/10/2011).

Fabry, B., Haberthur, C., Zappe, D. et al. (1997). Breathing pattern and additional work of breathing in spontaneously breathing patients with different ventilatory demands during inspiration pressure support and automatic tube compression. *Intensive Care*, **23**: 545–52.

Fernandez, R., Bacelar, N., Hernandez, G., et al. (2008). Ward mortality in patients discharged from the ICU with tracheostomy may depend on patient's vulnerability. *Intensive Care Medicine*, **34**: 1878–82.

Fikkers, B.G., Fransen, G.A., van der Hoeven, J.G., et al. (2003). Tracheostomy for long-term ventilated patients: a postal survey of ICU practice in The Netherlands. *Intensive Care Medicine*, **29**: 1390–3.

Fiorentini, A. (1992). Potential hazards of tracheobronchial suctioning. *Intensive and Critical Care Nursing*, **8**: 217–26.

Fitton, C., Myer, C.M. (1992). Practical aspects of paediatric tracheostomy care. *Journal of Otolaryngology*, **21(6)**: 409–13.

Formes, M., Cooke, J. (2007). Distal tracheal damage from suctioning: a review. London, Unpublished data collection.

Friedman, E., Kennedy, A., Neitzschman, H.R. (2003). Innominate artery compression of the trachea: an unusual cause of apnea in a 12-year-old boy. *Southern Medical Journal*, **96(**11**)**: 1161–4.

Frova, G. (1998). The difficult intubation and the problem of monitoring the adult airway. Italian Society of Anesthesia, Resuscitation, and Intensive Therapy (SIAARTI). *Minerva Anestesiologica*, **64**: 361–71.

Frova, G., Sorbello, M. (2009). Algorithms for difficult airway management: a review. *Minerva Anestesiologica*, **75(**4**)**: 201–9.

Gemma, M., Tommasino, C., Cerri, M., et al. (2002). Intracranial effects of endotracheal suctioning in the acute phase of head injury. *Journal of Neurosurgical Anesthesiology*, **14(**1**)**: 50–4.

Gianoli, G., Muller, R., Guarisco, J. (1990). Tracheostomy in the first year of life. *Annals of Otology, Rhinology, and Laryngology*, **99**: 896–901.

Glass, C.A., Grap, M.J. (1995). Ten tips for safer suctioning. *American Journal of Nursing*, **95**: 51–3.

Glendinning, C., Kirk, S., Guiffrida, A., Lawton, D. (2001). Technology-dependent children in the community: definitions, numbers and costs. *Child Care Health Development*, **27(**4**)**: 321–34.

Goldhill, D.R., Cook, T.M., Waldmann, C.S. (2009). Airway incidents in critical care, the NPSA, medical training and capnography. *Anaesthesia*, **64(**4**)**: 354–7.

Goldmann, K., Braun, U. (2006). Airway management practices at German university and university-affiliated teaching hospitals—equipment, techniques and training: results of a nationwide survey. *Acta Anaesthesiologica Scandanavica*, **50(**3**)**: 298–305.

Graham, C.A., Brittliff, J., Beard, D., McKeown, D.W. (2003). Airway equipment in Scottish emergency departments. *European Journal of Emergency Medicine*, **10**: 16–8.

Grap, M.J., Glass, C., Lindamood, M.O. (1995). Factors related to unplanned extubation of endotracheal tubes. *Critical Care Nurse*, **15**: 57–65.

Great Ormond Street Hospital. (2004). Tracheostomy ward decannulation http://www.gosh.nhs.uk/health-prefessionals/clinical-guidelines/ tracheostomy-care-and-management-review/ (accessed 31/01/2008).

Griggs, A. (1998). Tracheostomy: suctioning and humidification. *Nursing Standard*, **13(**2**)**: 49–53; quiz 55–6.

Hackeling, T., Triana, R., Ma, O.J., Shockley, W. (1998). Emergency care of patients with tracheostomies: a 7-year review. *American Journal of Emergency Medicine*, **16(**7**)**: 681–5.

Halfpenny, W., McGurk, M. (2000). Analysis of tracheostomy-associated morbidity after operations for head and neck cancer. *British Journal of Oral and Maxillofacial Surgery*, **38(**5**)**: 509–12.

Hamaker, R.C., Hamaker, R.A. (1995). Surgical treatment of laryngeal cancer. *Seminars in Speech and Language*, **16**: 221–32.

Hardwick, W.C., Bluhm, D. (1984). Digital intubation. *Journal of Emergency Medicine*, **1(**4**)**: 317–20.

Harkin, H., Russell, C. (2001). Preparing the patient for tracheostomy tube removal. *Nursing Times*, **97**: 34–6.

Harking, H., Russell, C. (2001). Preparing the patient for tracheostomy tube removal. *Nursing Times*, **97(**26**)**: 34–6.

Harlid, R., Andersson, G., Frostell, C.G., et al. (1996). Respiratory tract colonization and infection in patients with chronic tracheostomy. A one-year study in patients living at home. *American Journal of Respiratory and Critical Care Medicine*, **154(**1**)**: 124–9.

Harris, R.L., Riley, H.D. Jr. (1967). Reactions to aerosol medication in infants and children. *JAMA: The Journal of American Medical Association*, **201(**12**)**: 953–5.

Hazard, P. (1999). Tracheostomy. In Webb, A., Shapiro, M., Singer, M., Suter, P. (Eds). *Oxford Textbook of Critical Care*. Oxford, Oxford University Press, 1305–8.

Head and Neck Nurses Association of Ireland. (2000). Tracheostomy care guidelines. www.ncnm.ie/hanna/index.asp (accessed 18/6/2009).

Heafield, S., Rogers, M., Karnik, A. (1999). Tracheostomy management in ordinary wards. *Hospital Medicine*, **60**: 261–2.

Healthcare Improvement Scotland. (2007). Caring for the patient with a tracheostomy best practice statement. www.healthcareimprovementscotland.org/default.aspx?page=12044 (accessed 6/10/2011).

HEE eLfH. (2012). Tracheostomy safety. http://www.e-lfh.org.uk/projects/tracheostomy-safety/ (web-based resource, accessed 9/10/2013).

Heffner, J.E. (2001). The role of tracheotomy in weaning. *Chest*, **120(**6 Suppl**)**: 477S–81S.

Heidegger, T., Gerig, H.J., Henderson, J.J. (2005). Strategies and algorithms for management of the difficult airway. *Best Practice & Research Clinical Anaesthesiology*, **19**: 661–74.

Henderson, J.J., Popat, M.T., Latto, I.P., Pearce, A.C. (2004). Difficult Airway Society guidelines for management of the unanticipated difficult intubation. *Anaesthesia*, **59**: 675–94.

HES Online. Hospital episode statistics. www.hesonline.nhs.uk (accessed August 1/7/2011).

Hess, D.R. (2005). Facilitating speech in the patient with a tracheostomy. *Respiratory Care*, **50**: 519–25.

Hess, D.R. (2005). Tracheostomy tubes and related appliances. *Respiratory Care*, **50**: 497–510.

Hettige, R., Arora, A., Ifeacho, S., Narula, A. (2008). Improving tracheostomy management through design, implementation and prospective audit of a care bundle: how we do it. *Clinical Otolaryngology*, **33(**5**)**: 488–91.

van Heurn, L.W., Welten, R.J., Brink, P.R. (1996). A complication of percutaneous dilatational tracheostomy: mediastinal emphysema. *Anaesthesia*, **51**: 605.

Higginson, R., Jones, B., Davies, K. (2010). Airway management for nurses: emergency assessment and care. *British Journal of Nursing*, **19**: 1006–14.

Hooper, M. (1996). Nursing care of the patient with a tracheostomy. *Nursing Standard*, **10 (**34**)**: 40–3.

Hudak, M., Bond-Domb, A. (1996). Postoperative head and neck cancer patients with artificial airways: the effect of saline lavage on tracheal mucus evacuation and oxygen saturation. *ORL - Head & Neck Nursing*, **14(**1**)**: 17–21.

Hughes, M., Turnball, D., Mills, G. (2002). Sudden upper airway obstruction due to invisible rain out in the heat and moisture exchange filter. *British Journal of Anaesthesia*, **89(**2**)**: 335–45.

Intensive Care Society. (2008). Standards for the care of adult patients with a temporary tracheostomy. www.ics.ac.uk/intensive_care_professional/standards_and_guidelines/care_of_the_adult_patient_with_a_temporary_tracheostomy_2008 (accessed 3/7/2011).

Irving, R.M., Jones, N.S., Bailey, C.M., Melville, J. (1991). A guide to the selection of paediatric tracheostomy tubes. *The Journal of Laryngology & Otology*, **105(**12**)**: 1046–51.

Jackson, C. (1996). Humidification in the upper respiratory tract: a physiological overview. *Intensive and Critical Care Nursing*, **12(**1**)**: 27–32.

Jackson, K. (2000). Support following discharge: service audit. *Paediatric Nursing*, **12**: 37–8.

James, M.R., Milsom, P.L. (1988). Problems encountered when administering general anaesthetics in accident and emergency departments. *Archives of Emergency Medicine*, **5**: 151–5.

Jayson, S., Greenberg, M.S., De-Jong, A., Freidman, E.M. (2001). The role of post-operative chest radiotherapy in paediatric tracheostomy. *International Journal of Paediatric Otolaryngology*, **60**: 41–7.

Jennings, P. (1990). Caring for a child with a tracheostomy. *Nursing Standard*, **4(**32**)**: 38–40.

Kaiser, E.F., Seschachar, A.M., Popovich, M.J. (2001). Tracheostomy tube replacement: role of the airway exchange catheter. *Anesthesiology*, **94**: 718–9.

Kang, J. (2002). Using a self-learning module to teach nurses about caring for hospitalised children with tracheostomies. *Journal for Staff Development*, **18(**1**)**: 28–35.

Kannan, S., Birch, J.P. (2001). Controlled ventilation through a tracheostomy stoma. *Anaesthesia & Intensive Care*, **29**: 557.

Kapadia, F.N., Bajan, K.B., Raje, K.V. (2000). Airway accidents in intubated intensive care unit patients: an epidemiological study. *Critical Care Medicine*, **28**: 659–64.

Kapadia, F.N., Bajan, K.B., Singh, S., et al. (2001). Changing patterns of airway accidents in intubated ICU patients. *Intensive Care Medicine*, **27**: 296–300.

Kinloch, D. (1999). Instillation of normal saline during endotracheal suctioning: effects on mixed venous oxygen saturation. *American Journal of Critical Care*, **8(**4**)**: 231–40; quiz 241–2.

Klein, E.F. Jr., Graves, S.A. (1974). "Hot pot" tracheitis. *Chest*, **65(**2**)**: 225–6.

Kluge, S., Baumann, H.J., Maier, C., et al. (2008). Tracheostomy in the intensive care unit: a nationwide survey. *Anesthesia & Analgesia*, **107(**5**)**: 1639–43.

Kluger, M.T., Bullock, M.F. (2002). Recovery room incidents: a review of 419 reports from the Anaesthetic Incident Monitoring Study (AIMS). *Anaesthesia*, **57(**11**)**: 1060–6.

Kluger, M.T., Short, T.G. (1999). Aspiration during anaesthesia: a review of 133 cases from the Australian Anaesthetic Incident Monitoring Study (AIMS). *Anaesthesia* **54**: 19–26.

Kluger, M.T., Bukofzer, M., Bullock, M. (1999). Anaesthetic assistants: their role in the development and resolution of anaesthetic incidents. *Anaesthesia & Intensive Care*, **27**: 269–74.

Koneya, M., Barbour, A. (1976). Louder than words; nonverbal communication. Columbus, Ohio, Merrill.

Krishnan, K., Elliot, S.C., Mallick, A. (2005). The current practice of tracheostomy in the United Kingdom: a postal survey. *Anaesthesia*, **60(**4**)**: 360–4.

Kubba, H., Cooke, J., Hartley, B. (2004). Can we develop a protocol for the safe decannulation of tracheostomies in children less than 18 months old? *International Journal of Pediatric Otorhinolaryngology*, **68(7)**: 935–7.

Kun, S.S., Davidson-Ward, S.L., Hulse, L.M., Keens, T.G. (2010). How much do primary care givers know about tracheostomy and home ventilator emergency care? *Pediatric Pulmonology*, **45**: 270–4.

Kunz, R., Oxman, A.D. (1998). The unpredictability paradox: review of empirical comparisons of randomised and non-randomised clinical trials. *British Medical Journal*, **317**: 1185–90.

Kuzenski, B.M. (1978). Effect of negative pressure on tracheobronchial trauma. *Nursing Research*, **27**(4): 260–3.

Lavery, G.G., McCloskey, B.V. (2008). The difficult airway in adult critical care. *Critical Care Medicine*, **36**: 2163–73.

Leder, S.B. (2002). Incidence and type of aspiration in acute care patients requiring mechanical ventilation via a new tracheotomy. *Chest* **122(5)**: 1721–6.

Lewis, R.J. (1992). Tracheostomies. Indications, timing, and complications. *Clinics in Chest Medicine*, **13**: 137–49.

Lewis, T., Oliver, G. (2005). Improving tracheostomy care for ward patients. *Nursing Standard*, **19**: 33–7.

Littlewood, K.E. (2005). Evidence-based management of tracheostomies in hospitalized patients. *Respiratory Care*, **50**: 516–8.

Lomholt, N. (1982). Design and function of tracheal suction catheters. *Acta Anaesthesiologica Scandanavica*, **26**: 1–3.

Luce, J.M., Pierson, D.J., Tyler, M.L. (1998). *Intensive Respiratory Therapy* (2nd edition). Philadelphia, WB Saunders Co.

Luchetti, M., Pigna, A., Gentili, A., Marraro, G. (1999). Evaluation of the efficiency of heat and moisture exchangers during paediatric anaesthesia. *Paediatric Anaesthesia*, **9(**1**)**: 39–45.

Lyons, M.J., Cooke, J., Cochrane, L.A., Albert, D.M. (2007). Safe reliable atraumatic replacement of misplaced paediatric tracheostomy tubes. *International Journal of Pediatric Otorhinolaryngology*, **71(**11**)**: 1743–6.

Mallick, A., Bodenham, A.R. (2010). Tracheostomy in critically ill patients. *European Journal of Anaesthesiology*, **27**: 676–82.

Mallick, A., Venkatanath, D., Elliot, S.C., et al. (2003). A prospective randomised controlled trial of capnography vs. bronchoscopy for Blue Rhino percutaneous tracheostomy. *Anaesthesia*, **58(**9**)**: 864–8.

Marchese, S., Corrado, A., Scala, R., et al. (2010). Tracheostomy in patients with long-term mechanical ventilation: a survey. *Respiratory Medicine*, **104(**5**)**: 749–53.

Matsuura, K., Ebihara, S., Yoshizumi, T., et al. (1995). Changes in respiratory function before and after laryngectomy. *Nihon Jibiinkoka Gakkai Kaiho [Journal of Otolaryngology of Japan]*, **98**: 1097–103.

Mayo, P.H., Hackney, J.E., Mueck, J.T., et al. (2004). Achieving house staff competence in emergency airway management: results of a teaching program using a computerized patient simulator. *Critical Care Medicine*, **32(**12**)**: 2422–7.

McEleney, M. (2007). Endotracheal suction: a protocol for practice. *Paediatric Nursing*, **19(**10**)**: 14–18.

McGrath, B., Bates, L., Atkinson, D., Moore, J. (2012). Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. *Anaesthesia*, **67(9)**: 1025–41.

McGrath, B.A., Thomas, A.N. (2010). Patient safety incidents associated with tracheostomies occurring in hospital wards: a review of reports to the UK National Patient Safety Agency. *Postgraduate Medical Journal*, **86**: 522–5.

Merritt, R.M., Bent, J.P., Smith, R.J. (1997). Suprastomal granulation tissue and pediatric tracheotomy decannulation. *Laryngoscope*, **107(**7**)**: 868–71.

Midwinter, K., Carrie, S., Bull, P. (2002). Paediatric tracheostomy: Sheffield experience 1979–1999. *Journal of Laryngology*, **116**: 532–535.

Mirza, S., Cameron, D.S. (2001). The tracheostomy tube change: a review of techniques. *Hospital Medicine*, **62**: 158–63.

Morley, R., Thomson, H. (2009). *Failure of a Tracoetwist tracheostomy tube Anaesthesia*, **64(**7**)**: 791–2.

Mowery, B.D. (2002). Critical thinking in critical care: tracheostomy troubles. *Paediatric Nursing*, **28(**2**)**: 162.

Myles, P.S., Bain, D.L., Johnson, F., McMahon, R. (1999). Is anaesthesia evidence-based? A survey of anaesthetic practice. *British Journal of Anaesthesia*, **82**: 591–5.

Nee, P.A., Benger, J., Walls, R.M. (2008). Airway management. *Emergency Medicine Journal*, **25(**2**)**: 98–102.

Neill, K. (2001). Normal saline instillation prior to endotracheal suction. *Nursing in Critical Care*, **6**: 34–9.

Nelson, L. (1999). Wound care. Points of friction. *Nursing Times*, **95(**34**)**: 72–75.

Nelson, R. (2010). Countess of Chester tracheostomy policy (Personal communication).

Nolan, J.P., Soar, J., Zideman, D.A., et al. (2010). European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. *Resuscitation*, **81(**10**)**: 1219–76.

Norwood, M.G., Spiers, P., Bailiss, J., Sayers, R.D. (2004). Evaluation of the role of a specialist tracheostomy service. From critical care to outreach and beyond. *Postgraduate Medical Journal*, **80(**946**)**: 478–80.

NPSA. (2005). Protecting patients who are neck breathers. (Patient safety information leaflet 0149). www.nrls.npsa.nhs.uk/resources/?entryid45=59793 (accessed 22/7/2011).

Nursing and Midwifery Council. (2002). *Code of Professional Conduct for the nurse, midwife and health visitor* (4th edition). London, NM.

Odell, A., Allder, A., Bayne, R., et al. (1993). Endotracheal suction for adult, non-head-injured, patients. A review of the literature. *Intensive and Critical Care Nursing*, **9(**4**)**: 274–8.

Onakoya, P.A., Nwaorgu, O.G., Adebusoye, L.A. (2003). Complications of classical tracheostomy and management. *Tropical Doctor*, **33(**3**)**: 148–50.

Orme, R.M., Welham, K.L. (2006). Subcutaneous emphysema after percutaneous tracheostomy - time to dispense with fenestrated tubes? *Anaesthesia*, **61(**9**)**: 911–2.

Padley, A. (2001). Yet another use for the laryngeal mask airway--ventilation of a patient with a tracheostomy stoma. *Anaesthesia & Intensive Care*, **29**: 78.

Pandit, J.J., Popat, M.T., Cook, T.M., et al. (2011). The Difficult Airway Society 'ADEPT' guidance on selecting airway devices: the basis of a strategy for equipment evaluation. *Anaesthesia*, **66(**8**)**: 726–37.

Park, J.Y., Suskind, D.L., Prater, D., et al. (1999). Maturation of the pediatric tracheostomy stoma: effect on complications. *Annals of Otology, Rhinology, and Laryngology*, **108(**12**)**: 1115–9.

Paul, F. (2010). *Tracheostomy care and management in general wards and community settings: literature review*. *Nursing in Critical Care* **15(**2**)**: 76–85.

Peers, K. (2003). Cuff pressure. *Nursing Standard*, **17(**36**)**: 20.

Peirson, G.S. (1993). Home care protocols for pediatric tracheostomy patients. *Caring*, **12(**12**)**: 38–42.

Peterson, G.N., Domino, K.B., Caplan, R.A., et al. (2005). Management of the difficult airway: a closed claims analysis. *Anesthesiology*, **103(**1**)**: 33–9.

Picerno, N.A., Bent, J.P., Hammond, J., et al. (2000). Is tracheotomy decannulation possible in oxygen-dependent children? *Otolaryngology—Head & Neck Surgery* **123(**3**)**: 263–8.

Posner, J.C. (1999). Acute care of the child with a tracheostomy. *Pediatric Emergency Care*, **15(**1**)**: 49–54.

Powell, H., Hanna-Jumma, S., Philpott, J., Higgins, D. (2011). National survey of fenestrated versus non-fenestrated tracheostomy tube use and the incidence of surgical emphysema in UK adult intensive care units. *Journal of the Intensive Care Society*, **12**: 25–7.

Prasad, S.A., Hussey, J. (1995). *Paediatric Respiratory Care*. London, Chapman and Hall.

Pritchard, M., Flenady, V., Woodgate, P. (2001). Preoxygenation for tracheal suctioning in intubated, ventilated newborn infants. *Cochrane Database of Systematic Reviews* (3): CD000427.

Quigley, R.L. (1988). Tracheostomy—an overview. Management and complications. *British Journal of Clinical Practice*, **42**: 430–4.

Rajendram, R., McGuire, N. (2006). Repositioning a displaced tracheostomy tube with an Aintree intubation catheter mounted on a fibre-optic bronchoscope. *British Journal of Anaesthesia*, **97(**4**)**: 576–9.

Rauf, K., Zwaal, J.W. (2004). Accidental decannulation after surgical tracheostomy *Anaesthesia*, **59(**5**)**: 517.

Raymond, S.J. (1995). Normal saline instillation before suctioning: helpful or harmful? A review of the literature. *American Journal of Critical Care*, **4(**4**)**: 267–71.

Robbertze, R., Posner, K.L., Domino, K.B. (2006). Closed claims review of anesthesia for procedures outside the operating room. *Current Opinion in Anaesthesiology*, **19(**4**)**: 436–42.

Robert, V.K., Velthius, B., Lucas, W. (2001). Psychosocial problems arising from home ventilation. *American Journal of Physical Medicine and Rehabiliation*, **80(**6**)**: 439–46.

Rocha, E.P., Dias, M.D., Szajmbok, F.E., et al. (2000). Tracheostomy in children: there is a place for acceptable risk. *Journal of Trauma*, **49(**3**)**: 483–5; discussion 486.

Ronczy, N.M., Beddome, M.A. (1990). Preparing the family for home tracheotomy care. *AACN Clinical Issues in Critical Care Nursing*, **1(2)**: 367–77.

Rosenstock, C., Ostergaard, D., Kristensen, M.S., et al. (2004). Residents lack knowledge and practical skills in handling the difficult airway. *Acta Anaesthesiologica Scandanavica*, **48(**8**)**: 1014–8.

Rossi Ferrario, S., Zotti, A.M., Zaccaria, S., Donner, C.F. (2001). Caregiver strain associated with tracheostomy in chronic respiratory failure. *Chest*, **119(**5**)**: 1498–502.

Rusakow, L.S., Guarin, M., Wegner, C.B., et al. (1998). Suspected respiratory tract infection in the tracheostomy in chronic respiratory failure. *Chest*, **119(**5**)**: 1498–502.

Russell, C. (2005). Providing the nurse with a guide to tracheostomy care and management. *British Journal of Nursing*, **14**: 428–33.

Russell, C., Harkin, H. (2001). The benefits of tracheostomy specialist nurses. *Nursing Times*, **97**: 40–1.

Russell, C., Matta, B. (Eds). (2004). *Tracheostomy: A Multi-Professional Handbook*. London, Greenwich Medical Media Ltd.

Sagarin, M.J., Barton, E.D., Chng, Y.M., Walls, R.M. (2005). Airway management by US and Canadian emergency medicine residents: a multicenter analysis of more than 6,000 endotracheal intubation attempts. *Annals of Emergency Medicine*, **46**: 328–36.

Saini, S., Taxak, S., Singh, M.R. (2000). Tracheostomy tube obstruction caused by an overinflated cuff. *Otolaryngology - Head & Neck Surgery*, **122**: 768–9.

Schwid, H.A., Rooke, G.A., Carline, J., et al. (2002). Evaluation of anesthesia residents using mannequin-based simulation: a multiinstitutional study. *Anesthesiology*, **97**: 1434–44.

Scoble, M.K., Copnell, B., Taylor, A., et al. (2001). Effect of reusing suction catheters on the occurrence of pneumonia in children. *Heart & Lung*, **30(**3**)**: 225–33.

Seay, S.J., Gay, S.L. (1997). Problem in tracheostomy patient care: recognizing the patient with a displaced tracheostomy tube. *ORL - Head & Neck Nursing*, **15**: 10–1.

Seay, S.J., Gay, S.L., Strauss, M. (2002). Tracheostomy emergencies. *American Journal of Nursing*, **102(**3**)**: 59, 61, 63.

Seay, S.J., Gay, S.L., Strauss, M. (2002). Tracheostomy emergencies. *American Journal of Nursing*, **102**: 59–63.

Seefelder, C., Kenna, M.A. (2000). Don't rely on the surgical airway: a case of impossible tracheostomy. *Paediatric Anaesthesia*, **10(2)**: 224–5.

Shah, R.K., Lander, L., Berry, J.G., Nussenbaum, B., Merati, A., Roberson, D.W. (2012). Tracheotomy outcomes and complications: a national perspective. *Laryngoscope*, **122(**1**)**: 25–9.

Sharma, R. (2008). *Mask for stoma ventilation: rescue using a Rendell-Baker-Soucek mask after a dislodged tracheostomy tube*. *Acta Anaesthesiologica Scandanavica*, **53(**4**)**: 1305–6.

Shiber, J.R., Fontane, E. (2007). Digital tracheal intubation: an effective technique that should not be forgotten. *American Journal of Emergency Medicine*, **25(**6**)**: 726.

Showmaker, J.A., Page, M.P. (2010). Life-threatening tension subcutaneous emphysema as a complication of open tracheostomy. *Otolaryngology - Head & Neck Surgery* **142**: 628–9.

Sigler, B.A., Willis, J.M. (1985). *Nursing Care of a Patient with a Tracheostomy*. London, Churchill Livingston.

Simpson, S. (2009). *Airway Suctioning*, CPC Guidelines. London, Great Ormond Street Hospital.

Sleigh, M.A., Blake, J.R., Liron, N. (1988). The propulsion of mucus by cilia. *American Review of Respiratory Disease*, **137(**3**)**: 726–41.

Smith, M.C., Shrestha, K.B., Agrahari, K.N. (1995). Humidification after tracheostomy: simple techniques. *Tropical Doctor*, **25(**1**)**: 38–9.

South East Wales Critical Care Network. (2009). Tracheostomy guidelines, 2009. www.wales.nhs.uk/sites3/Documents/736/Tracheostomy Guidelines Policy.pdf (accessed 12/10/2011).

Spence, K., Gillies, D., Waterworth, L. (2003). Deep vs shallow suction of endotracheal tubes in ventilated neonates and young infants. *Cochrane Database of Systematic Review*, **3**: CD003309.

St George's Hospital NHS Trust. Tracheostomy guidelines. www.stgeorges.nhs.uk/trachindex.asp (accessed 3/8/2011).

Stafford, R.A., Benger, J.R., Nolan, J. (2008). Self-inflating bag or Mapleson C breathing system for emergency pre-oxygenation? *Emergency Medicine Journal*, **25(**3**)**:153–5.

Stamou, D., Papakostas, K., Turley, A. (2010). Airway loss after recent tracheostomy: use of digital confirmation. *Anaesthesia*, **65(2)**: 214–5.

Stringer, K.R., Bajenov, S., Yentis, S.M. (2002). *Training in airway management Anaesthesia*, **57(1)**: 967–83.

Suiter, D.M., McCullough, G.H., Powell, P.W. (2003). Effects of cuff deflation and one-way tracheostomy speaking valve placement on swallow physiology. *Dysphagia*, **18**: 284–92.

Tarnoff, M., Moncure, M., Jones, F., et al. (1998). The value of routine posttracheostomy chest radiography. *Chest*, **113(6)**: 1647–9.

Thomas, A.N., McGrath, B.A. (2009). Patient safety incidents associated with airway devices in critical care: a review of reports to the UK National Patient Safety Agency. *Anaesthesia*, **64**: 358–65.

Tobin, A.E., Santamaria, J.D. (2008). An intensivist-led tracheostomy review team is associated with shorter decannulation time and length of stay: a prospective cohort study Published online 11/4/2008. *Critical Care*, **12(2)**: R48; doi: 10.1186/cc6864.

Trottier, S.J., Ritter, S., Lakshmanan, R., et al. (2002). Percutaneous tracheostomy tube obstruction: warning. *Chest*, **122**: 1377–81.

Tsitouridis, I., Michaelides, M., Dimarelos, V., Arvaniti, M. (2009). Endotracheal and tracheostomy tube-related complications: imaging with three-dimensional spiral computed tomography. *Hippokratia*, **13**: 97–100.

Tweedie, D., Skillbeck, C.J., Cochrane, L.A.C., et al. (2008). Choosing a paediatric tracheostomy tube: an update on current practice. *The Journal of Laryngology & Otology*, **122(2)**: 161–9.

Underwood, S.M., McIndoe, A.K. (2005). Influence of changing work patterns on training in anaesthesia: an analysis of activity in a UK teaching hospital from 1996 to 2004. *British Journal of Anaesthesia*, **95(5)**: 616–21.

Valentin, A., Capuzzo, M., Guidet, B., et al. (2006). Patient safety in intensive care: results from the multinational Sentinel Events Evaluation (SEE) study. *Intensive Care Medicine*, **32**: 1591–8.

Vickers, M.D. (2002). Anaesthetic team and the role of nurses - European perspective. *Best Practice & Research in Clinical Anaesthesiology*, **16**: 409–21.

Waddell, A., Appleford, R., Dunning, C., et al. (1997). The Great Ormond Street protocol for ward decannulation of children with tracheostomy: increasing safety and decreasing cost. *International Journal of Pediatric Otorhinolaryngology*, **39(2)**: 111–8.

Waldron, J., Padgham, N.D., Hurley, S.E. Complications of emergency and elective tracheostomy: a retrospective study of 150 consecutive cases. *Annals of the Royal College of Surgeons of England* 1990; **72(4)**: 218–20.

Walz, J.M., Zayaruzny, M., Heard, S.O. (2007). Airway management in critical illness. *Chest*, **131(2)**: 608–20.

Wang, K.W., Barnard, A. (2004). Technology-dependent children and their families: a review. *Journal of Advanced Nursing*, **45(1)**: 36–46.

Warrington and Halton Hospitals NHS Foundation. (2010). Management of displaced tracheostomy tubes in ICU (Personal communication).

Webber-Jones, J. (2010). *Obstructed tracheostomy tubes: clearing the air Nursing*, **40(1)**: 49–50.

Weiss, Y.G., Deutschman, C.S. (2000). The role of fiberoptic bronchoscopy in airway management of the critically ill patient. *Critical Care Clinics*, **16**: 445–51.

While, A.E. (1991). An evaluation of a paediatric home care scheme. *Journal of Advanced Nursing*, **16(12)**: 1413–21.

Whitaker, D.K. (2011). Time for capnography - everywhere. *Anaesthesia*, **66**: 544–9.

Wood, C.J. (1998). Endotracheal suctioning: a literature review. *Intensive Critical Care Nursing*, **14(3)**: 124–36.

Woodrow, P. (2002). Managing patients with a tracheostomy in acute care. *Nursing Standard*, **16**: 39–46.

Yaremchuck, K. (2003). Regular tube changes to prevent formation of granulation tissue. *Laryngoscope*, **113(1)**: 1–10.

Young, C.S. (1984). Recommendation for suction. *Physiotherapy*, **70(3)**: 104–6.

Young, C.S. (1984). Recommended guide lines for suction. *Physiotherapy*, **70(3)**: 106–8.

Young, J.S., Brady, W.J., Kesser, B., Mullins, D. (1996). A novel method for replacement of the dislodged tracheostomy tube: the nasogastric tube "guidewire" technique. *Journal of Emergency Medicine*, **14(2)**: 205–8.

Index

Advanced life support (ALS)
calling for assistance
conventional facemask
emergency equipment
high-pressure ventilation
inner tube removal
primary emergency oxygenation
secondary emergency oxygenation
suctioning
tube insertion, false passage
waveform capnography

Airway flags

Artificial humidification
cold
documentation
heat moisture exchanger (HME)
heated
humidification ladder
hydration
instilled saline
methods of
mobilisation
mucolytics
patient assessment
saline nebulisation
secretions management
stoma filters/bibs

Basic life support (BLS)
breathing assessment
chest compressions
inner tube removal
ongoing resuscitation
opening the airway

pulse check
rescue breathing
safety
shouting
stimulation
suctioning
training for carers

Björk flap incision

Blocked tracheostomy

Breathing flags

Bronchomalacia

Buchanan bib

Capnography

Chest compressions

Competency assessment
implementation at LTHTR
implementation at SRFT
statement

Complications
altered body image
blocked tracheostomy
communication
delayed
displaced tracheostomy tube
haemorrhage
immediate
late
local infection
pneumonia
red flags
speaking valves
tracheal damage/ischaemia

Cuff deflation
documentation
key actions related to
leaks
patient assessment

Cystic hygroma

Daily considerations
artificial humidification. *See* Artificial humidification
bedside equipment
cuff management
daily checks
decannulation
information sheets for patients
inner cannulae management
oral care
patient assessment
speech after laryngectomy
stoma care. *See* Stoma care
suctioning
swallowing assessment. *See* Swallowing assessment
tracheostomy tube. *See* Tracheostomy tubes
weaning

Decannulation
documentation
dressing
equipment
key actions related to
patient positioning
post decannulation
stoma site
timing of

Decision making

Displaced tracheostomy tube

Emergency management
assistance
bedhead signs
bedside capnograph
bedside information and algorithms
Bougie insertion
draft guidelines
green algorithm. *See* Green algorithm
oral intubation
oxygenation of
paediatric facemask/ laryngeal mask
primary responder
red algorithm
secondary responder
tracheal stoma, occlude
two airway teams

Flap suture incision

Green algorithm
breathing assessment
help and equipment
tracheostomy. *See* Tracheostomy

Haemangioma

Haemorrhage

Horizontal slit incision

Hospital incident reporting system (HIRS)

Human error
communication
critical incident rehearsals and simulation experience

decision making
error chains
fatigue
situation awareness

Infrastructure considerations
bed managers
care plans
chief executive
chief nurse
consultant
critical care outreach team
critical care/specialist ward clinical staff
emergency teams
executive medical director
general managers
heads of nursing
HIRS
hospital inpatient management
key performance indicators
matrons and ward managers
receiving ward clinical staff
risk assessment

Laryngectomy
definition
green and red bedhead signs
stomas
supraglottic
total

Laryngomalacia

Mapleson C anaesthetic breathing system

Minitrach tubes

Paediatric tracheostomy
accidental decannulation/tube displacement
vs. adult airways
advanced life support (ALS). *See* Advanced life support (ALS)
airway anatomy
basic life support (BLS). *See* Basic life support (BLS)
equipment checklist
essential equipment and environment
feeding
haemorrhage
humidification
indications for
infection
initial care
new tracheostomy flow chart
patient follow-up
patient observations
planned (elective) tube changes
post-procedural tube check
staff and carer competency guides
suctioning
surgical emphysema
tape changes (cotton)
tape tension for
Trachi-dressing
tube blockage

Papillomatosis

Percutaneous tracheostomy
advantages of
bronchoscope
dilator
endoscopic view of
needle and guide wire placement
Seldinger technique
vs. surgical tracheostomy
tissue alignment

tracheostomy kit

Pneumonia

Red flags
airway flags
blood-stained secretions
breathing flags
displaced tracheostomy tube
general flags
increased discomfort/ pain
prompt assessment of

Seldinger technique

Speech and language therapist (SALT)

Stoma care
aseptic technique
documentation
dressing types
granulation tissue
inflamed sutures
key actions related to
patient assessment
pressure wound
radiotherapy
standard bedside equipment
tracheostomy dressings

Sub-glottic stenosis

Suctioning
catheter insertion
catheter selection
catheter withdrawal
clinical hand wash
complications of

depth of
equipment
equipment for
frequency of
key actions related to
patient assessment
pressures for
tracheostomy tube length
types of
vacuum pressure

Swallowing assessment
blue dye use
cuff deflation
documentation
dysphagia signs
fibreoptic endoscope
inflated tracheostomy tube
key actions related to
therapies
video fluoroscopy

Tracheal stenosis

Tracheomalacia

Tracheostomy
Adam's apple/thyroid cartilage
altered body image
anaesthesia
anaesthetic considerations
anterior neck anatomy
competency assessment. *See* Competency assessment
complications. *See* Complications
daily considerations. *See* Daily considerations
dead space reduction
definition
electronic communication board
emergency management. *See* Emergency management

flange position
history of
human error. *See* Human error
humidification and filtering of air
incidents
indications for
infrastructure considerations. *See* Infrastructure considerations
inner tubes
long term/permanent
NTSP courses
NTSP researchers
obstructing (decannulation) caps, inappropriate use
open laryngectomy stoma
paediatric. *See* Paediatric tracheostomy
patient positioning
patient preparation
percutaneous. *See* Percutaneous tracheostomy
red flags. *See* Red flags
reduced appetite
structures surrounding the sites
suction catheter
swallowing mechanics
temporary
tube removal
upper airway lateral view

Tracheostomy tubes
abnormal airway anatomy
adjustable flange
'blind' insertion
choice of
clinical environment
cuffed tubes
double-cannula tubes
fenestrated tubes
'guided' tube changes
key actions related to
obstructed/absent upper airway
oxygenation maintenance

patient assessment
patient preparation
respiratory function
single-cannula tubes
speaking
with sub-glottic suction
tracheal dilators
tube dimensions
uncuffed tubes

Trauma

Vertical slit incision

Vocal cord immobility

Waveform capnography

Weaning
cuff deflation
digital occlusion
documentation
key actions related to
patient assessment
speaking valves and caps
varying tube size

Window incision

UPLOADED BY [STORMRG]